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THE AMERICAN
JOURNAL OF PHARMACY

VOL. 95. JULY, 1923. NO. 7.

EDITORIAL

THE OPIUM PROBLEM.

Not the problem of analysis, nor of the standardization of preparations or therapeutic indications thereof, but the problem, now become international, of controlling the abuse. Alcohol and morphine. Two gifts of plant chemistry to the world which have been probably, in certain lines, as beneficial to mankind as any natural or artificial substance, yet have brought untold miseries into existence. The abuse of alcohol dates back to the most ancient times of which we have written record. Whether the cave-man knew how to make intoxicating beverages we cannot say, but the narrative of Noah's drunkenness evidences an early acquaintance of the Orient with the free use of wine, and the Code of Hamurabi, which is probably not less than three thousand years old, contains regulations of taverns, recognizing them as liable to be the resort of the criminal classes, thus pointing to the social peril of the sale of intoxicants on the plains of Mesopotamia in the morning twilight of civilization.

Alcohol is far more easily obtained than morphine; substances susceptible of fermentation have a far wider range of growth. The opium plant is restricted in its range, and with unimportant exceptions is the only one from which the alkaloid can be obtained, while alcohol is easily produced from any sugar or starch-bearing plants and such are found in all parts of the world. The fermented juice of the grape was among the earliest of the intoxicating beverages. The fact that species of yeast are found usually on the grape-skin causes the fermentation to result promptly on crushing the fruit, hence ancient peoples thought that the process was entirely spontaneous. Drunkenness in all its phases is, therefore, a widely and long-known phenomenon, but the "opium habit," whether by smoking or eat-

ing, has been confined until comparatively recent centuries to certain races in the Far East. Still more recently the invention of the hypodermic syringe has offered a new method of use. Except as to opium smoking, morphine may be considered as the equivalent of the crude material, and in this article the two will be considered identical. The spread of the opium habit among western nations cannot be due to restrictions in the sale of alcoholic beverages, for the vice was extensively developed years before such restrictions were operative, and the fact that the problem has been brought before a Hague convention shows that it is rife in parts of the world in which alcohol prohibition is non-existent. The habit, therefore, is due to some specific susceptibility of human beings.

Allusion has just been made to a Hague Convention rule. This is a non-export provision. The problem that it presents is discussed at some length in the *Schweizerishe Apotheker-Zeitung* (1923, lxi, 254). Switzerland has not accepted the rule. It is, indeed, the fatal defect of these international assemblies that they have no power of enforcing their decrees. The decisions may or may not be accepted by the several nations, even though adopted by a large majority of the delegates. If a Hague court is to be established, it is to be hoped that some of the greater nations will enter it sincerely, and be prepared not only to accept its decisions on all matters that concern themselves, but also be ready to enforce them on other nations by military and naval means, if necessary.

A dark phase of the struggle of a nation against the opium problem was the war waged from 1842 to 1850 by Great Britain to force China to receive the opium grown in India. Not only were the Chinese driven to allow the importation of the drug, but the British secured as indemnity the island of Hongkong, of great strategic value, and about $20,000,000. Great Britain is a signatory to the Hague agreement, and this has, as the Swiss journal states, thrown dust in the eyes of many persons, for there is still an underhand protection of the nefarious traffic by British interests. Off Canton, the chief port of southern China, lies the island of Macao, on which for more than a century a large manufactory of smoking opium has been in operation under a concession to the Portuguese government. Large sums have been paid to that government as shares in the profits. The Chi-

nese government has repeatedly protested against this factory, the products of which go in enormous volume through all parts of China. The island houses a few Portuguese soldiers, with some old-fashioned cannon, that could make no defense against a small, well-equipped army, but should the Chinese government attempt to back up its intentions with a resort to arms, it would be but a short time before a British warship would land a force sufficient to show that Great Britain, the traditional protector of Portuguese interests, was ready to bring that unconquered sea-power to the rescue of the villainous establishment.

Sir Francis Aglen, general inspector of sea-tariffs, and one of the most influential foreigners in the service of the Chinese government, expressed in the London *Times* of April 5, last, the view that the abuse of opium in China has little relation to the regulations that have lately been adopted in Europe and America concerning the use of the drug. Some years ago, the Chinese government succeeded in materially restricting within its borders the production of opium, but promptly enormous amounts of morphine and acetyl-morphine were sent from America and Europe, of course, smuggled in as substitutes for opium. This traffic has been abated, but the consumption of opium in China is increasing in consequence of the renewal of the growing of the poppy. Aglen regards the problem in China as hopeless from the point of view of drastic restriction. He favors the legalization of opium production in China and the imposition of a tax. Such a system has, indeed, been put in operation in one of the provinces. The Opium Convention in Ghent avoided one of the most difficult phases, that of the production and use of opium in India, holding the latter to be "lawful use" ("usage légitime").

The study of this subject gives rise to some speculations as to the relative viciousness of the several habits that are now so common among mankind, namely the use of alcohol, tobacco and opium. The last-named is under wide social ban. Excess in the use of either alcohol or tobacco does not result in the ostracism that almost invariably follows even the restricted use of opium, its alkaloids and allied substances. Laudanum drinkers have long been known. Before the days of restrictive legislation, every drugstore had its customers, and it was the usual practice to keep on the shelves two forms of tincture, one, offi-

cial, for prescription service, the other much weaker, for habitues, who were mostly wastrels, pitied or despised, but not considered as criminals. Federal enactments have changed all this. The sale of certain habit-forming drugs, other than under prescription, and the use of them other than so prescribed, are offenses, subjecting to severe penalties. Alcohol has lately, in this country, come into the same class, and many anticipate that if the crusade against John Barleycorn is soon victorious, onslaught will be made on My Lady Nicotin. A discussion of this probability is out of the scope of this article. It is certainly germane for the sociologist and psychologist to investigate the basis of the difference between the general reaction of society to the drunkard and the dope fiend. For many years alcoholic intoxication was the only type of drug intoxication familiar in the leading civilized countries, the occasional opium (laudanum) user attracting but little notice. Courts, indeed, have not infrequently regarded drunkenness as a mitigating circumstance in connection with crime, but such a view is not customary nowadays, especially when the drunken man is driving an automobile. In society at large, even the most exclusive type, excessive use of alcohol has not been considered as disqualification for any position of "honor, trust or profit," but a knowledge that a person was in the habit of using morphine, cocaine or heroin would almost surely put such person under social ban, even before the days of the present severe enactments against such practices. Yet it would seem, in a fair consideration of what is commonly called "personal liberty," that if A has the privilege to put into his mouth alcohol which steals away his brains, B should have the privilege to use morphine for the same purpose, even though the physiologic effects are unlike, except that both are disgusting and dangerous to the individual and society. Drunkenness is, however, a "gentleman's vice." Resort to other toxic substances is not. As a matter of fact there are no "rights" or "personal liberties" in the question. The community determines the limits of free action of its members, and when it perceives a custom leading to damage to the body politic or interfering with comfort and efficiency of a considerable mass of citizens, it puts its veto upon such custom, and provides penalties for violation of its laws. In an organized community the individual members surrender their self-control to a large ex-

tent. Civilized man, in his present complex organization, has no "rights," but only "duties." Wise statesmen will, of course, apply such principles with caution, restraining only where the freedom is obviously detrimental to the mass.

In the last analysis, the opposition to the restriction of the manufacture and sale of all habit-forming drugs is due to economic interests. It is the profit that accrues to the makers and vendors of these substances. While there are doubtless many persons in the United States who are honestly of the opinion that alcohol is beneficial to human beings, and that the drastic restriction of its use is a violation of personal liberty and human rights, the propaganda against the recent legislation would be but feeble if not backed by the monetary support of the industries devoted to the manufacture of such beverages, and the same forces are back of the resistance to control of the free and extensive sale of morphine and cocaine and their analogues.

H. L.

A QUESTIONABLE BUSINESS PRACTICE.

To the stockroom of a Philadelphia hospital there came, a few months ago, a packing case containing a dozen bottles (pints) of medicated alcohol. The person in charge of the stores not having the requisition duplicate for this material, placed the goods aside in anticipation of a later bill or voucher. After a few weeks the superintendent received a bill from a firm in another city for one dozen pints of special alcohol, ridiculously priced, and this was turned over to the storekeeper for verification. The bill was returned with the customary check for quantity and condition of goods. But there was no duplicate requisition sheet nor any recollection of an order to purchase.

For this reason the hospital forwarded a letter to the firm named on the billhead, and received in return a letter stating that these goods were sent on approval some months before and the bill was only sent after sufficient time had elapsed to warrant the supposition that the goods had been used. In answer to this letter the firm was notified that insofar as these goods were not formally ordered payment would not be rendered and

the goods would remain untouched for the time. Then came a letter requesting the hospital to return the goods, express collect.

Again the hospital sent a communication stating that insofar as this was not their usual way of conducting business, it would be necessary for the firm to instruct their agents to call for the said goods within five days, or the goods would be turned over to the junk dealer, and a bill for storage charges sent to the consignors. The following answer was received and is printed herewith in its original form. The reader will sense the sarcastic humor contained between its lines and draw his own conclusions of the business ethics of a firm that practices such underhanded and furtive selling methods.

"Gentlemen:

"We are in receipt of your communication in which you advise us that you would turn over the goods we sent to you on approval to a junk dealer, if we did not call for them promptly. Whilst we are thoroughly in accord with you that you are within your legal rights in not wishing to extend to us the courtesy of asking your local office of the Express Company to call for the goods to return to us, all charges collect, we fail to see why you would destroy perfectly good medicinal preparations which could advantageously be used in your institution, particularly in these days when hospitals are crying out loud for contributions.

"These goods are standard and are undoubtedly being purchased by you from time to time. If you do not wish to use these goods free of all charges, please have the goodness to ask some other local institution to call for same and use them with our compliments."

We have since learned of several other hospitals who paid the bill for material thus delivered, simply because the red tape of storeroom records made it almost necessary to render payment on any goods which had been accepted by the storeroom and written upon the inventory records. Any firm that plays upon chance sales such as these, and particularly aiming their unfair selling shafts at charitable institutions, deserves to be held up at every possible opportunity, and hospital pharmacists and superintendents will do well to cancel such unfair dealers from their buying lists.

I. G.

ORIGINAL ARTICLES

IRON AND IRON ALLOYS.*

Frank X. Moerk, Ph. M.

Professor of Analytical Chemistry, Philadelphia College of Pharmacy and Science.

Wrought iron and steel were known to the ancients; the tempering of steel also antedates exact history. Cast iron became known at a much later period, when the increased manufacture of iron finally led to the construction of the blast furnace, in which the heat of reaction of large quantities of iron and the presence of excess of carbon gave a liquid mass which could be cast. The first construction of any size in England was a bridge built in 1788. The immense development of the iron and steel industry began in 1856 with the manufacture of Bessemer steel.

"The total value of all mineral products in the United States in 1913, the last normal year before the World War, was approximately $2,500,000,000. Of this, a little more than one-third, or $883,000,000, was for metallic products of which almost exactly one-half is due to pig iron. The United States produces far more iron and steel than any other nation, her total output being fully 40 per cent. of the world's production."

Iron is undoubtedly the most important of the metals. Were all the gold of the world destroyed by magic, after the financial convulsion had adjusted itself to the loss of this measure of value and some new standard had been agreed upon, industry would move on at its usual speed. With iron similarly removed, industry would be pitifully helpless. There would be practically no tools or machines with which to work, and, worse still, nothing to make them with and little from which they could be made. The abundance of iron, the comparative ease with which it is obtained from its ore, its strength, and its adaptability are the chief reasons for the wonderfully important part it plays in human affairs. Of its adaptability Bradley Stoughton in "Rogers' Industrial Chemistry" says:

"Iron can be made either the strongest or one of the weakest of metals; either the most magnetic or one of the non-magnetic

*One of a Series of Popular Lectures, delivered at the Philadelphia College of Pharmacy and Science, 1922-1923.

metals; one of the hardest or one of the softest; one of the toughest or one of the most brittle; it may have a coefficient of expansion which changes in atmospheric temperature varying almost from zero to a maximum, and it may be given a combination of some of these different properties at will, according to the purpose for which it is to be fitted in service. And most of these variations are brought about by changing the amount of foreign elements by less than 5 per cent. of the mass, or by giving it a different heat treatment, or by both together."

The most important chemical properties of iron from a practical standpoint are: First, its liability to oxidation in damp air (rusting); second, the ease with which its oxides (ores) are reduced at all temperatures above 500° F. (260° C.), and, third, its very powerful chemical affinity for carbon.

Its most important physical properties are its strength, magnetism and ability to become hardened and to retain a durable cutting edge after appropriate manufacture and treatment. In these three properties it can be made to excel all other known substances. Add to them its cheapness, and we can understand the importance of the ferrous metals to industry and civilization.

Ores.—The chief ores are the oxides, Fe_2O_3 and Fe_3O_4; the former occurs anhydrous in hematite (red) and hydrated in brown hematite and limonite. In only a few localities is the carbonate important. Unless the proportion of iron is at least 35 to 40 per cent., the ore cannot be smelted with profit, except where the cost of mining plus mechanical concentration is low.

Cast Iron.

Over 95 per cent. of all the iron ore treated goes into the blast furnace, where it is generally smelted with coke, an appropriate flux (usually limestone) and preheated air yielding a relatively impure grade of metal known as pig iron.

Because of its impurity and therefore its friability, pig iron cannot be worked or wrought. Many millions of tons per year are used in the form of castings, and the remainder purified. The purification consists in oxidizing the carbon, silicon and other impurities, thereby converting it into wrought iron and steel.

Malleable Cast Iron.—Iron castings lack strength and ductility on account of the impurities contained and more especially on account of the large flakes of graphite, which destroy the continuity of the metallic mass. On the other hand, steel castings are costly to make, not only because of the expense of the manufacture of the steel, but chiefly because of the relative infusibility and high shrinkage on cooling. A between-product has therefore been developed to which the name of malleable "cast iron" has been given, because, although its composition approaches that of ordinary cast iron, it differs from it in having a limited amount of malleability. It also has greater strength than cast iron and a very moderate degree of ductility. Malleable cast iron is made by first making castings of white cast iron in which the carbon is usually under 3 per cent. and all in the combined form; these castings are then maintained at a bright red heat for two or three days or more, which results in the carbon being precipitated in very minute flakes of graphite, known as "temper carbon." Temper carbon differs from graphite chiefly in the small size of its particles, and the characteristics of malleable cast iron are due to this difference and also, in lower degree, to the circumstance that the amount of carbon and phosphorus is less.

Wrought Iron.

Wrought iron is produced by heating cast iron in a puddling furnace, lined with hematite to furnish oxygen, the flame from a fire at the side being led over the charge, which is wrought or worked during the process. At the end of about one and a half hours the carbon, silicon and manganese are almost entirely eliminated, as well as a portion of the phosphorus and sulphur. The iron is then drawn from the furnace in a pasty state, because the heat is no longer sufficient to maintain it in the liquid form in this purified condition. Wrought iron so produced is one of the purest of the iron-steel products. Its distinguishing characteristic is the webs and strings of slag mixed with it, which are drawn out by the hammering or rolling process, and give the metal its fibrous structure; on account of the freedom from carbon it lacks great strength and cannot be made to take a temper. Wrought iron is a term now little used, for it has in a large measure been replaced by soft steel, but there is still a demand for it for certain purposes.

Steel.

This form of iron may be made by a variety of processes, from either pig iron or wrought iron.

The immense development of the steel industry began in 1856, when the acid Bessemer process was perfected, in which the molten cast iron is placed in an iron converter lined with some difficultly fusible material (siliceous), and a current of air turned on.

The complete purification of ten to twenty tons of liquid pig iron requires only seven to fifteen minutes. The heat produced by the oxidation of the impurities is sufficient not only to keep the bath in the liquid condition during the operation, but also to raise its temperature more than 575° F. (300° C.). The liquid metal, however, dissolves a good deal of iron oxide, which has a very harmful effect upon its qualities, but is nearly all removed by the addition of manganese at the end of the "blow." The appearance of the "converter" flame gives an index by which the operation may be followed and controlled. When the oxidation of impurities is completed, the flame shortens, or "drops," and the blowing is discontinued. Then is added a predetermined amount of manganese to remove absorbed oxygen; silicon to prevent gas bubbles or "blow-holes," and carbon to give the desired degree of strength or hardness, or both. Bessemer steel is the lowest in price and poorest in quality, and in America this process is now rapidly giving way to the basic open-hearth process, chiefly because the supply of ore from which pig iron can be made, suitable for the Bessemer process, is yearly running lower. The great field of the Bessemer process has been in the manufacture of railroad rails, wire and pipe. For the two latter commodities it bids fair to retain its predominance for a time at least, because it is especially adapted to the manufacture of steel low in carbon.

Basic Bessemer.—Acid Bessemer slags are rich in silica, and this prevents the elimination of phosphorus from the metal, because silica will force phosphorus out of the slag unless there is a great predominance of basic radicals present to unite with both silica and phosphoric acid. By lining the converter with basic material, using pig iron low in silicon and using large quantities of lime, a basic slag is produced which retains the phosphorus. The success depends upon a high phosphorus content in the pig iron in order to supply the necessary heat.

Acid Open-Hearth.—The pig iron, to which some scrap steel or iron ore is generally added, is placed in a reverberatory furnace lined with siliceous material; the hot gases will burn out some of the impurities but will not remove phosphorus and sulphur. The process yields the best grades of structural steel and steel castings.

Basic Open-Hearth.—In this process the furnace is lined with magnesite or dolomite and the phosphorus, silicon, manganese and carbon are oxidized to as low a point as may be desired, the first three passing into the slag. An important, although somewhat uncertain, amount of sulphur is also carried into the slag as CaS. This steel is liable to contain dissolved oxide and also to be impregnated with gas bubbles or "blowholes." The process can be used with a number of ores containing phosphorus, which would not be available otherwise.

Duplex Process.—A combination of the acid Bessemer and basic open-hearth processes, of recent importance, enables rapidity of working and elimination of phosphorus. The pig iron is blown in the converter until the silicon and manganese and about half the carbon are eliminated, when it is transferred to the open-hearth furnace, where the remainder of the carbon and the phosphorus is oxidized.

Crucible Steel.—If wrought iron be heated with charcoal, pig iron or some other substance rich in carbon so that the resulting metal will contain from 0.75-1.50 per cent. carbon, it makes a steel which is largely used for cutting tools and similar purposes, and is the highest in quality and price.

Electric Iron and Steel.—Electric furnaces, introduced since 1900, are coming into use, yielding a higher grade of steel than the crucible process; they are also the only means of producing some of the "ferro-alloys," because sufficiently high temperature cannot be otherwise obtained, and because operations can be carried out in a non-oxidizing atmosphere.

Electrolytic Iron.—Ferrous chloride solution is used as the electrolyte, cast iron as the anode and a revolving mandrel as the cathode; the iron is of 99.97 per cent. purity, with traces of carbon, silicon, sulphur and phosphorus. Before stripping the iron tube, the mandrel with deposited iron is heated to expel hydrogen, which causes brittleness in the iron to such an extent that it can be pow-

dered. This iron is almost as soft as pure copper or aluminum, has better cold-working or drawing qualities, is resistant to corrosion or tarnishing, has 10 to 20 per cent. greater conductivity than steel and if copper-clad will have the conductivity increased by another 20 per cent. without showing the objectionable stretching qualities of copper in transmission lines. Thin tubes, which are the most expensive to make, are made directly by this process.

By using a graphite anode, some of the ferrous chloride is oxidized to ferric chloride and this can be used to react with sulphide ores, forming ferrous chloride and precipitating sulphur; the ferrous chloride solution is electrolyzed and the cycle of reactions gives 97 per cent. of the iron and 90 per cent. of the sulphur content of the ore.

Analytical Constituents of Iron and Steel.

Until a comparatively recent period the differences between wrought iron, steel and cast iron were explained on the basis of the carbon content, the lowest amount in wrought iron and the highest amount in cast iron. In the analyses of iron and steel, combined carbon, graphitic carbon, sulphur, phosphorus, silicon and manganese were reported.

Combined carbon was known to increase the strength of steel up to about 0.9 per cent., after which it has a weakening effect; it decreases the ductility, toughness, malleability, magnetic power and electric conductivity; it increases the hardness and brittleness.

Graphite is found as a rule only in "mottled" and "gray" cast irons.

Sulphur increases the "red-shortness" of iron and steel (brittleness at a red heat); it should not exceed 0.10 per cent. and in high grades less than 0.035 per cent. is specified; present as manganous sulphide, and if Mn be insufficient also as ferrous sulphide.

Phosphorus increases the "cold-shortness" of the metal (brittleness at ordinary temperatures), especially if the metal be subjected to shock; is present as phosphide and, if in fairly large quantities, frequently segregates and appears during the turning, cutting and filing as harder and whiter masses which are known to the workmen as "ghosts."

Silicon may be present as silicide but more generally as silicate in entrained slag of which very little should be present in good steel; chemical analyses report total silicon; is added to steel to

prevent gas bubbles or blowholes and is added to cast iron to precipitate carbon in the graphitic form, thus softening the metal.

Manganese is added to steel to remove sulphur and dissolved oxide and to neutralize the harmful effect of the oxygen which it is not able to remove; manganese oxide and sulphide are not as harmful to steel as iron oxide and sulphide. Steel free from manganese is difficult to roll and requires special care for successful shaping.

Corrosion of Iron and Steel.

This constitutes the greatest weakness of iron and steel from the industrial standpoint and involves a loss of millions of dollars each year. It is now recognized that the quality of manufacture has a much greater effect than the process of manufacture. The rusting of iron requires both oxygen (air) and water; neither one alone can cause rusting. Iron or steel with entangled slag, occluded gas, blowholes or which is not of uniform composition (segregation) will rust more rapidly, due to the development of a difference of potential. After rust spots once show, corrosion is intensified because the rust (ferric hydroxide) acts negatively towards the metal, thus producing a difference of potential.

A number of the more familiar metals (many of which are used for the protection of iron) arranged in the order of their diminishing solution tensions gives the following tension series: Mg, Zn, Al, Cd, Fe, Ni, Ph, Cu, Sn, Sb. Metals having higher solution tensions (those preceding iron in this list) will protect iron from corrosion until they have entered solution or have been oxidized; metals having lower solution tensions (those following iron in this list) will protect iron if they form a continuous coating, but should the coating be broken the corrosion of the iron will be more rapid.

Iron which has been dipped in certain strong oxidizing agents no longer exhibits a solution pressure when dipped in dilute electrolytes and comports itself as though it were a noble metal; dipped in fuming nitric acid it no longer dissolves in dilute acid nor does it displace copper and silver from solutions; as this so-called "passive" condition is not a stable condition there is a continual tendency at work which causes the return to the normal surface condition. Chromic acid and chromate solutions also produce this unstable state; iron immersed in a potassium dichromate solution (1 : 13000), with access of air, showed no signs of rusting after two months.

These statements can be illustrated by making so-called "Ferroxyl" mounts: A 1.5 per cent. aqueous solution of agar-agar is made by boiling for one hour, replacing the evaporated water, filtering while hot, adding 2 cc. phenolphthalein solution for every 100 cc., neutralizing exactly with KOH or HCl as may be necessary, and finally adding 7 cc. of potassium ferricyanide solution (1 per cent.) for every 100 cc. Enough of this solution is poured into a Petri dish to cover the bottom and congealed by floating the dish in cold water; the specimens are then placed on this bed of jelly, completely covered with more of the hot reagent, and allowed to cool without disturbance. The colors, red at the negative and blue at the positive pole, sometimes show up immediately, but may require from twelve to twenty-four hours to attain their most perfect development. Imbedded metals, sheet iron or nails: The red color develops where the iron is protected, the blue color where it is oxidized; frequently several poles are noticed due to non-uniformity (segregation) of the metal. Iron and zinc in contact with each other: The iron will be protected (red color) while the zinc will be oxidized (shown by a white coating). Iron and copper in contact with each other: Will show the copper protected (red color) while the iron is oxidized (blue color). Two specimens of the same iron, one of which is rendered "passive" by immersion for several hours in a potassium dichromate solution, not in contact with each other, will show that the "passive" does not respond. The mounts may be preserved for months by keeping the agar covered with alcohol.

A modification of this test is used to reveal pin holes in tin plate due to imperfect coating: Acidify a hot 15 per cent. gelatin solution with dilute sulphuric acid, add a small quantity of potassium ferricyanide solution and float upon the surface of the tin plate to be tested; the gelatin solution solidifies upon cooling and in a very short time every pin hole on the tin surface will be marked by a spot of Turnbull's blue.

Preservation of Iron and Steel.

There are a number of specimens of manufactured iron which have withstood the action of the elements of long periods; the most notable is the iron column of Kutab Minar in Delhi, India, said to have been erected in 900 B. C., but also stated to be sixteen hundred years old. Chains and structural iron in use for fifty to

one hundred years, and still in good condition, on analysis disclosed the presence of 0.35-0.54 per cent. copper. At the present time a large quantity of copper-steel containing 0.2-0.3 per cent. copper is being used for galvanized and tinned iron; exposure of this copper-steel, without any protecting coating, for over five years failed to show any notable signs of corrosion.

Steel used for rails, chains, implements, boiler tubes, *etc.*, cannot be protected by any coating; for this class the problem of preservation will likely depend upon the manufacture of a purer iron, homogeneous in character, or possibly upon the discovery of a cheap rust-resisting alloy; the alloys first known to have this property contain Ni, Cr, Va, and are too expensive. Iron is now made in quantity containing 0.16 per cent. total impurities, also a copper-steel containing 0.2-0.5 per cent. copper, both announced as quite resistant to corrosion.

Boilers and Boiler Tubes.—The corrosion of these is due to electrical action and to oxygen. Zinc, as a more electro-positive metal, has been used to prevent corrosion, but is not entirely satisfactory because good contact cannot be maintained between it and the iron, and also because the area in which the protective action takes place is restricted; a number of organic reducing agents, tannin, pyrogallol, *etc.*, have been used to remove oxygen. Alkaline hydroxides, carbonates and phosphates have preservative action in addition to the property of softening the water and preventing the formation of scale. Soluble chromates, for reasons before stated, are in use as protecting agents. The most practical method depends upon the exclusion of oxygen from the feed water; by using feed-water heaters all dissolved gases can be expelled before the water enters the boilers.

Metallic Coatings.

Galvanized Iron.—Probably over one-half of the zinc produced is used for the protection of iron, which is due to its higher solution tension and is accomplished mainly at the expense of its own destruction.

Three methods are used in galvanizing iron:

(1) The "hot dip" or hot-galvanized method in which iron is cleansed by passing through HCl (sometimes $ZnCl_2$ and NH_4Cl are added) before entering the bath of molten zinc. If pure zinc were

used at the start it would be speedily contaminated with iron; commercial zinc or spelter contains Pb, Cd and Fe. If the deposited zinc contains above 3 per cent. iron, the coating becomes too brittle to bend; lead up to 1 per cent. is harmless, but 1.5 per cent. will not dissolve in the zinc, but will segregate and if deposited on the iron will form weak spots; the scum forming on the surface of the molten zinc also prevents an even and homogeneous layer of zinc. The crystalline surface on galvanized iron is improved by the addition of a small quantity of antimony to the zinc.

Pure zinc dissolves slowly in acids, but impure zinc by local currents dissolves rapidly; iron, coated with impure zinc, is more rapidly corroded.

(2) The wet-galvanized, cold, or electrolytic method, as the name indicates, deposits the zinc from solution. The deposit is practically pure zinc, but more porous than in the "hot-dip" method; the process is slow and after the coating attains a certain thickness the deposit has a tendency to become rough and crystalline; there is also difficulty in securing an even distribution of current, especially on irregularly shaped articles.

(3) The vapor-deposition or Sherardizing method is effected in two ways, namely, the "zinc-dust process" and the "molten zinc vapor process." In the former, zinc dust and the iron articles are heated to about 600° F. (315° C.) in an air-tight iron drum placed in a gas-fired furnace. In the latter the materials to be coated are placed in a cage or hollow drum which is slowly rotated inside of a cylinder into which zinc vapor and hydrogen gas or other reducing agent are forced. An advantage of the vapor-deposition method is the even coating on screw threads, pipe fittings and machine work. Sherardized material on exposure assumes a peculiar black, sooty color and then appears to be very resistant to corrosion.

Cross-sections of articles coated by the three methods and etched with iodine show in the electrolytic method only zinc and iron (no alloy); in the other two methods there are shown zinc, zinc-iron alloy and iron.

Tinned Iron or Tin Plate.—Tin is next to zinc in importance for protecting iron; the method employed for coating iron is similar to the "hot-dip" method for galvanizing. Tin, electro-negative to iron, has such a low solution tension that it is practically incorrodible. The most important uses are for roofing, cans and tinned

utensils. Coatings on steel are apt to contain pin holes, but prevented by the addition of ferro-phosphorus to the steel.

Terne Plate.—Made by immersing sheet iron in a bath of molten lead-tin alloy; may contain as high as 88 per cent. lead, used extensively for roofing.

Lead-Coated Iron.—This is of minor importance; 7 per cent. or more of tin present with the lead.

Copper-Coated Iron.—Made by immersion in copper sulphate solution or by electrolytic deposition; used in form of wire, sheet and plate metal, also for cheap hardware, in which case it is generally given a sulphide treatment and burnished, producing a mottled effect.

Brass-Coated Iron.—Made by electrolytic deposition; used for imitations of genuine brass articles as hardware, jardinieres, curtain rods, *etc.;* unless protected by lacquer will rust.

Nickel-Coated Iron.—Made by electrolytic deposition; used for hardware, bathroom fixtures, *etc.;* gives better service than the two preceding, especially if lacquered.

Chromium-Coated Iron.—The electrolytic deposition of chromium upon iron, steel and other metals is a recent achievement; resistant to corrosion and dilute acids.

Antimony-Coated Iron.—Deposited from antimony chloride solution; used on rifle and gun barrels as a protection against rusting.

Aluminum-Coated Iron.—Process known as "Calorizing"; operation similar to Sherardizing, using, instead of powdered zinc, a mixture of powdered aluminum and aluminum oxide; used to protect iron at high temperatures; the diffusion of aluminum into iron proceeds slowly up to 900° C., rapidly between 1000° and 1200° C.; at high temperatures forms a closely adhering coating of aluminum oxide which prevents the corrosion of the iron. Used for wire, heating units, grids, stove burners, gas engine exhaust mufflers, condensers for cracking oils, glass-annealing ovens, *etc.*

These various treatments have for their object the preservation of iron; *Feralun* is a product which protects man from accidents due to worn or smooth iron and is made by pressing some hard abrasive into molten iron. Used for stair treads and all other flat surfaces upon which persons are likely to slip.

Metallic Oxide Coating.

Magnetic Oxide of Iron (Fe_3O_4).—This is produced by heating iron or steel in a coating chamber to 800-1000° C. and injecting superheated steam; the operation is repeated until a sufficient coating is obtained.

The same result may be produced by making the iron the anode or positive pole in a hot NaOH electrolyte, using a high amperage and low voltage current; to obtain a coating of sufficient thickness the poles may have to be reversed several times.

The deposit is negative to iron; therefore protection is afforded the iron only so long as the coating is perfect; damage to the coating with exposure of the iron will lead to accelerated corrosion.

Useful for hardware, grillings, railings, scroll and fancy work; Russia Iron, used for stovepipes, locomotive cases, *etc.*, has a coating of the same composition.

Paint and Lacquer Coatings.

The great bulk of finished iron and steel is protected by coating with paint. In the study of paints the pigments and vehicles must be considered. Slightly soluble chromates are used as pigments, due to the action of soluble chromates in preventing the rusting of iron.

Pigments are classified as inhibitive (rust-preventative), neutral or indeterminate and stimulative (rust-accelerating); as soluble salts, electrolytes, stimulate corrosion pigments should be thoroughly washed to insure removal of foreign salts.

Vehicles.—Linseed oil, first in importance, owes its value to the property of drying when exposed to the air; the drying can be hastened by boiling the oil with oxides and salts of metals, as zinc, lead, manganese, which act as carriers of oxygen. The film of dried oil, called linoxyn, should be elastic and hard but not brittle; it always contains voids or pores and is not waterproof, even if mixed with pigments in the finest powders. The addition of solutions of varnish gums will fill up these pores and render the film more resistant to gases and moisture. Linseed oil, applied to iron and allowed to dry, becomes an active stimulator of corrosion if the film is abraded in the least degree; this action is reduced in a marked degree if pigments are first mixed with the oil. Boiled linseed oil, as stated above, contains small quantities of metallic compounds

which aid its drying; as a paint vehicle raw or unboiled linseed oil is mixed with boiled oil (2:1) or the latter replaced by a small amount of so-called

Japan driers, which are made by fusing resins with the metallic compounds mentioned under linseed oil, and dissolving the product in turpentine.

Chinese wood oil, after boiling with metallic compounds which act as carriers of oxygen, will form on exposure a hard, elastic film, more moisture-resistant than that from linseed oil; used with linseed oil gives a glossier film.

Soja bean oil, unboiled, dries slowly; mixed with an equal volume of heavy blown linseed oil gives good results; boiled, has been used for varnishes.

Turpentine, used as a diluent or thinner, makes paint flow more easily, but if used in too large quantities gives a matt, porous surface.

Liquid Coatings.

Paints.—Liquid mixture containing pigments, linseed oil, drier, varnish, and turpentine; small additions of paraffin and carnauba wax make paint more waterproof. Rust-stimulating pigments should never be placed in contact with iron or steel surfaces; an inhibiting priming coat should always intervene; this inhibiting coating may be suitably compounded of inhibitors or of any of the indeterminate or neutral pigments reinforced with a small proportion of the stronger inhibitors; over this priming coat the air- and moisture-excluding coats can then be safely applied.

The Paint Manufacturers' Association of the United States furnished the American Society for Testing Materials, for the purpose of observation, a series of several hundred iron plates 24x36 inches, very carefully painted with paints made up of various pigments. These panels were set up near Atlantic City, N. J., in the fall of 1908, and annual inspections made to determine the relative protecting value of the different paints. These were graded on a basis of 1-10 and grades of excellence were marked 8-10; the following table shows the ratings (in the last three years only the ten highest are given):

	1910	1911	1912	1913	1914
American Vermilion (Basic lead chromate)	9.8	10.	9.9	9.8	7.5
Chrome Green (blue tone)	9.7	9.8	8.6	7.6	5.
Zinc and Barium Chromate	9.7	9.5	8.5	7.8	—
Sublimed Blue Lead	9.6	8.8	9.	7.2	6.
Lead and Zinc Chromate	9.5	9.7	9.2	8.3	4.
Magnetic Oxide of Iron	9.5	9.5	8.6	7.8	4.
Sublimed White Lead	9.5	9.	8.1	—	—
Zinc Chromate	9.4	9.5	8.8	8.	4.
Prussian Blue W. S.	9.2	9.	—	6.7	—
Bright Red Oxide of Iron	9.3	8.1	—	—	—
Natural Graphite	9.1	6.8	—	—	4.
Medium Chrome Yellow	9.	7.7	—	—	—
Orange Mineral	9.	8.3	—	—	—
White Lead (Quick Process)	8.9	4.2	—	—	—
Willow Charcoal	8.8	8.8	8.6	7.9	4.5
Prussian Blue W. I.	8.8	8.5	—	—	—
Red Lead	8.7	8.3	8.1	—	4.
White Lead (Dutch Process)	8.7	3.7	—	—	—
Zinc Lead White	8.	4.7	—	—	—
Venetian Red	—	8.	—	—	—
Carbon Black + Barytes	—	—	—	6.8	5.

Lacquers.—Gum lacquers are made by dissolving gums like kauri, sandarac, shellac, in alcohol, acetone, fusel oil, *etc.* Applied with a brush and sometimes baked.

Cotton lacquers are solutions of soluble guncotton or cellulose acetate, or phosphate, in amyl acetate and diluted with acetone, wood alcohol, benzin, *etc.* Articles to be coated must be dipped, as brushing causes streaking.

Combination lacquers are mixtures of the two preceding classes, the solvents of which have been properly adjusted to prevent settling out or curdling of either constituent.

Lacquers have not been used to any extent for protecting iron or steel, but a chromated lacquer has given good results in protecting iron articles on a small scale; it is made by dissolving shellac in alcohol, filtering and adding chromic acid in very small portions until the solution is saturated. To prevent the alcohol from catching on fire, the solution should be kept cool.

Coal Tar.—Refined by heating to remove water, acetic acid and some of the lighter oils, has been found useful applied alone or after admixture with lime and portland cement.

Baked Japan.—Compounded largely of high-grade asphaltic gums with kauri or other fossil gums, are applied by dipping; the material to be protected is heated and, after coating, baked until hard.

Enamel.—Used as a protection for sheet iron and culinary utensils. A fusion is made from 30 parts powdered feldspar and 25 parts borax, the melt powdered and mixed with 10 parts kaolin, 6 parts feldspar, 1.75 parts magnesium carbonate and sufficient water to make a paste, which is spread over the cleaned iron; upon this is applied a fusible powder made by fusing 37.5 parts quartz, 27.5 parts borax, 50 parts stannic oxide, 15 parts sodium carbonate and 10 parts potassium nitrate; the coated article is then dried in a hot room and heated in a muffle furnace to about 700° C. to fuse the enamel.

Robertson Process Asbestos-Protected Metal.—Used for roofing, sidings, water conductors, *etc.;* fastened with Sherardized bolts. Cleaned sheet steel is asphalt-coated, then encased in asbestos felt saturated with asphalt and, finally, covered with a waterproof coating applied at a high temperature. Not acted upon by acid vapors.

Applications.

Iron and steel articles are frequently coated with mineral oil or grease; if these articles are to be painted, this oil or grease must be removed; otherwise the paint will not dry perfectly.

Structural metal is most generally primed with red lead, but as this pigment is made by several processes the products may not furnish the same protection. A high-grade hematite with 2 to 5 per cent. zinc chromate is as effective as good red lead.

Railroad ties, poles and posts, which are partly sunk into the ground, are best protected by a hot application of a mixture of coal tar, lime and portland cement.

Pipes coated with linseed oil are afterwards immersed in heated coal-tar pitch, or a mixture of this with linseed oil, and baked.

Galvanized iron, because of the greasy nature of the zinc coating, is difficult to prime; if sharp-toothed siliceous pigment ground in varnish is well applied, subsequent coatings may be of any desired formula; sometimes the surface is wetted with a copper solution, the separated copper, after drying, offering less difficulty in priming.

Tinned iron in its manufacture is generally coated with a film

of palm oil, which should be removed by use of turpentine or benzin; A good priming coat is made of 98 per cent. ground hematite and 2 per cent. zinc chromate ground in oil with or without the addition of varnish.

Refrigeration machinery protection has been one of the most difficult problems; a priming coat containing asbestine (magnesium silicate), willow charcoal, red lead and zinc chromate ground in oil with the addition of 40 per cent. kauri-gum varnish has given excellent results.

Letter boxes, which looked so nice with their coating of aluminum paint were not protected from corrosion; a good bronze-green, inhibitive, can be made from zinc oxide and chromate, white lead and willow charcoal.

Ships' bottoms: Formulas found satisfactory by the Government are as follows: Anti-corrosive paint—7.25 gals. grain alcohol, 7.9 lb. shellac, 0.6 gal. turpentine, 0.6 gal. pine-tar oil, 9.5 lb. dry metallic zinc and 28.5 lb. dry zinc oxide. Anti-fouling paint—6 gals. grain alcohol, 13.75 lb. shellac, 1 gal. turpentine, 1 gal. pine-tar oil, 13.75 lb. dry zinc oxide, 13.75 lb. Indian red and 4.75 lb. red mercuric oxide. Both formulas make ten gallons.

Behavior of Iron and Iron-Carbon Alloys During Cooling.

The important stages in developing the modern view of the constituents of iron and steel are as follows:

Widmanstetten in 1808, microscopic examination;

Anossow in 1856, microscopic examination of metallurgical specimens;

Sorby in 1864, microscopic examination after etching;

Osmond and Werth in 1883, study of the changes due to quenching;

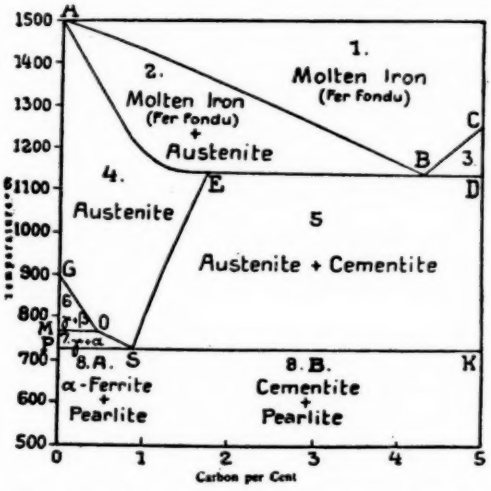
Osmond in 1894, classical study of the constitution of iron and steel;

An international committee report in 1912 on the nomenclature of iron and steel constituents.

Pure iron is capable of existing in three allotropic modifications; if a cooling curve be taken of the purest iron, obtained by electro-deposition, two remarkable irregularities (transformations) occur in the curve, due to evolution of heat in each case, and attended by important changes in the physical properties. The first of these transformations is noted at (G) 917° C. and is due to the

change of gamma-iron into beta-iron; the second transformation is noted at (M) 769° C. and is due to the change of beta-iron into alpha-iron.

Alpha-iron exists below 769° C., beta-iron between 769° and 917° C., gamma-iron above 917° C.; the first two crystallize in cubes and are capable of forming isomorphous mixtures; gamma-iron crystallizes in octahedra and does not form isomorphous mixtures with beta-iron but is the only one of the three which can dissolve carbon, forming a solid solution, known as austenite; alpha-iron only is magnetic. The temperatures stated, varying from those indicated in the illustration, are taken from L. Guillet and A. Portevins's "Metallography and Macrography," 1922.



Steels containing up to 0.3 per cent. carbon give three transformation points, shown by the lines G-O, M-O and P-S; G-O indicates the separation of beta-iron, the carbon concentrating in the remaining austenite; M-O the conversion of beta-iron into alpha-iron; P-S the separation of alpha-iron with the breaking down of the austenite into pearlite (0.9 per cent. carbon) and alpha-iron. The final constituents therefore are ferrite (alpha-iron) and pearlite (an aggregate of six parts of ferrite and one part cementite).

Any point along G-O is frequently indicated as "A_3"; the temperature of which decreases with increasing carbon content and eventually may merge with "A_2" on the line M-O, the temperature of which is independent of the carbon content; points along the line

P-S, frequently indicated as "A_1", correspond to the formation of pearlite (also called "the eutectoid") the quantity of which increases with the carbon content up to the point S, 0.9 per cent. carbon.

These transformation points may be reached by cooling from a higher temperature or by heating from a lower temperature; to make a distinction the former are indicated as "Ar_3", "Ar_2", and "Ar_1"; the latter as "Ac_3", "Ac_2", and "Ac_1"; "Ar_1" is also known as the "recalescence" point because attended by a considerable evolution of heat; "Ac_1" therefore must be attended by a corresponding absorption of heat.

Steels containing between 0.3 and 0.9 per cent. carbon give two transformation points: the $A_{3\cdot2}$ point, corresponding to the line O-S, is depressed as the carbon content increases and indicates the separation of ferrite from some of the austenite with concentration of carbon in the remaining austenite; the A_1. 725° C. with the change of the remaining austenite into ferrite and pearlite.

Steels containing between 0.9 and 1.7 per cent. carbon have two transformation points: the first along the line S-E (E 1150° C.) corresponds to the separation of cementite, Fe_3C (6.7 per cent. carbon); this point rises rapidly with the carbon content and is frequently indicated as Acm; when the austenite reaches a carbon content of 0.9 per cent. the second point $A_{3\cdot2\cdot1}$ indicates the change into pearlite.

Steels containing over 1.7 per cent. carbon have but one transformation point, namely, $A_{3\cdot2\cdot1}$ along the line P-S.

Alloys containing between 1.7 and 4.3 per cent. carbon will deposit during solidification austenite along A-B and solidification will be completed by the formation of the eutectic, cementite-austenite, at B; from this solid solution cementite separates until 1.7 per cent. carbon is left in solution at point E 1130° C. and 0.9 per cent. carbon at point S 725° C., at which temperature pearlite is formed.

Alloys containing between 4.3 per cent. and 6.7 per cent. carbon will deposit during solidification cementite along B-C and solidification will be completed by the formation of the eutectic, cementite-austenite, at B; further changes then as in the preceding case.

THE EVOLUTION OF CHEMICAL TERMINOLOGY.

By James F. Couch.

VI. HYDROXIDE.

Comme ce sont les mots qui conservent les idées & qui les transmettent, il en résulte qu'il seroit impossible de perfectioner la science, si on n'en perfectionoit le langage—*Lavoisier.*

The lack of ambiguity in the practical use of the term hydroxide may well occasion surprise that a consideration of this term has been included in this series of papers upon chemical terminology. There are few chemical terms more often used and certainly there is none which is used by the chemist with more specific meaning. It is one of the first items of information that he receives in his elementary course in chemistry. It stares at him from his little shelf of reagents in the laboratory and it would not be exaggeration to say that the first example of applied chemistry he learns is the broad principle that hydroxides neutralize acids and may, therefore, remedy accidents to fabrics. His most indispensable reagents are sulphuric acid and sodium hydroxide and he comes to know these substances as a painter knows brushes and a sculptor knows marbles. The chemist grows up in science with the concept hydroxide; it is always with him; it is ever in use; it finally becomes immanent in his very nature. Why, then, should he not be completely familiar with it? Where is there possibility of ambiguity or misconception in the use of this term?

From the foregoing it is easy to believe that I have never met the chemist who does not cherish a conviction that he knows what an hydroxide is. It requires more courage, however, to supplement that assertion with the statement that I have not yet met a chemist who really does know what an hydroxide is, and, furthermore, it is not at all difficult to convince any reasonable chemist that his knowledge in this respect is incomplete. If he doubts this a very few adroit questions will serve to bring him to an impasse and demonstrate the fact.

Some months ago I set out to investigate this term hydroxide. The examination of available facts led to the astonishing conclusion that there is no general agreement in the definition of the term, so that, strictly speaking, unless one specifically

modifies the word when he uses it, he says next to nothing definitely when he employs the term hydroxide. In other words, we have here a most flagrant example of indefiniteness. Here is a concept which is in daily use, which enters into a large portion of all chemical thought, which underlies and conditions many important chemical theories; and it lacks the *sine qua non* of scientific terms, precise meaning!

This fact immediately becomes apparent upon consultation of the dictionaries and the textbooks of chemistry. We find a diversity of opinion among authorities when, as is not always the case, they venture to define the term. Many writers of inorganic chemistries present no definition of hydroxide, but content themselves with referring to the formation of basic hydroxides through the interaction of water and alkaline oxides or by the reaction between sodium hydroxide and certain metallic salts. The various expressed views of the term hydroxide may be classified under four chief concepts: there is the view that these substances are compounds of water with oxides; fundamentally opposing this is the view that hydroxides are hydroxyl compounds and of this conception there are three main divisions: first, the idea that any hydroxyl compound is an hydroxide, second, the common notion which may briefly be stated thus, hydroxides are hydroxyl compounds of basic radicals, and third, a compromise between these extremes which allows the class hydroxide to embrace all hydroxyl compounds but prefers its application to basic substances.

The first view has few proponents today. It was, however, held by most of the early chemists and has been supported by very capable men. D'Aubuisson [1] in 1810 wrote:

> "Mineralogists and chemists have too little fixed their attention on water considered as a constituent of minerals with the exception of those salts in which this substance has been remarked under the name water of crystallization. Meanwhile the rocks of which it forms an essential constituent part are in great number; without mentioning those which compose the numerous family of the zeoliths I will cite the wavelite recognized by Davy and Klaproth as a true hydrate of alumina, composed of water and alumina in constant proportion. Diaspore . . . seems to be nothing but a hydrate of the same earth. The opal is probably only a hydrate of silica."

This quotation is interesting through the knowledge it gives us concerning conditions in chemistry a century ago. It appears that only a very few chemists had any real conception of the importance of water as a constituent in compounds and consequently it was too often overlooked. Berzelius,[2] however, grasped the significance of combined water and in 1812 developed an hypothesis to explain it which influenced chemical thought for several decades. This was his notion of acid and basic water:

> "Hydrate, oder Verbindungen des Wassers: Erstens: mit Säuren. In diesen spielt das Wasser ganz die Rolle einer Basis; die Säure nimmt davon zur Sättigung eine Menge auf, welche genau so viel Sauerstoff als eine Salzbasis enthält, von der diese Mange Säure gesättigt wird.
>
> "Zweitens: mit Salzbasen. Das Wasser spielt hier in so fern die Rolle eine Säure, als es ihre Stelle vertritt, enthält aber nur gleiche Theile Sauerstoff mit der Basis, oder ist zuweilen ein submultiplum vom Sauerstoff der Basis."

He uses the term hydrate freely speaking of "Hydrate der Thonerde" and "Eisen Hydrate." Vauquelin[48] in 1813, repeating an analysis published by Prof. Bruce of New York, confirmed the findings of the American:

> "It appears from this analysis that the mineral which formed the subject of it is simply a combination of magnesia and water (hydrate of magnesia)."

Vogel,[49] writing in 1818 "Sur les Hydrates," defined them thus:

> "When water unites with a solid body and preserves with it the solid state, it is in this case, only, that one gives to the combination the name of hydrate."

He refers to soda and potash as hydrates and mentions the hydrate of lead. None of these authors used the term hydroxide, for, at this time, it had not been generally accepted. Graham,[23] considering water as a constituent of salts, does not employ the term hydroxide, but he had the concept, for he distinguishes carefully between the water combined in acids and that in bases following the hypothesis of Berzelius already quoted. Thus Graham:

"In the hydrates of the caustic alkalies and of the earths, water is retained by a strong affinity, and is generally supposed to be united, like an acid, to the alkali or earth. In such hydrates water discharges an *acid* function."

"In the case of hydrates of the acids,* the portion of water which is found to be inseparable by heat, or to be very strongly retained, has generally been presumed to be in the place of a base to the acid, although little attention has been paid to the subject. The most highly concentrated sulphuric acid retains one atom of water, and is supposed to be a sulphate of water."

In the "Hand-Book of Chemistry" of Leopold Gmelin,[20] published in 1849, we begin to get a more definite statement about water-compounds; he defines oxides:

"The act of combination of oxygen with other bodies is called oxygenation (combustion); also acidification, when the resulting compound is of an acid nature; oxidation in the contrary case. The oxygen is the oxygenizing body (supporter of combustion); also, according to circumstances, the acidifying or the oxidizing body." v. 2, p. 38.

"Oxygen forms about 136 inorganic compounds; they are as follows:

1. Of acid nature . . .
   a. Non-metallic oxygen acids . . .
   b. Metallic oxygen acids . . .
2. Compounds not of acid nature: Oxides." v. 2, p. 38.

Gmelin does not use the term hydroxide, which, indeed, was not common in Germany, the word hydrate being there used. It is clear, however, that his idea of hydrates was that of the modern concept of basic hydroxides and there can be no doubt that, had the question been raised, he would not have extended the term hydroxide to include the oxy-acids. Silliman [46] is not so definite:

". . . it combines with many substances, forming a large class of hydrates: hydrate of lime and potash are examples. It is also, as we have seen, essential to the acid

*It is hardly necessary to remind the reader that at this era the oxy-acids were not regarded as hydrogen compounds, but what we now term the acid anhydrides, or acidic oxides, were termed acids and the combinations of these oxides with water were called hydrates of the acids.

properties of common sulphuric, phosphoric, and nitric acids, acting here the part of a much more energetic base than in the hydrates." p. 249.

He seems, nevertheless, inclined to limit hydrates to basic compounds. Newth [37] unequivocally assumes this position:

"Binary compounds that are formed by the union of elements with oxygen are called the oxides of these elements. Certain of these oxides are capable of entering into combination with water, giving rise to substances known as acids; such acids are distinguished as acid-forming oxides, or acidic oxides. They are also sometimes termed anhydrides. All the non-metallic elements, except hydrogen, form oxides of this order, and the acids derived from them are known as the oxy acids.

"Certain other oxides also unite with water, but give rise to compounds known as hydroxides. When such oxides, which are all derived from the metallic elements, are brought into contact with acids, chemical union takes place, and a compound termed a salt is formed. Such oxides are distinguished as salt-forming or basic oxides. There are also oxides which are neither acidic nor basic." p. 17.

These quotations serve to present a clear picture of the notion that hydroxides are water compounds and they show in addition the diversity of opinion in respect to the limits of application of the term. It will be observed that, while the term hydrate is used throughout in most of the citations, the writers clearly had in mind those compounds which today would be termed hydroxides. We turn then to the consideration of the view that hydroxides are hydroxyl compounds and first examine the broadest application of this view.

This conception is not of very great age. It appears only a short time before the publication of the theory of ionization. Fownes,[50] in 1885, and this is the earliest reference to this specific concept that I have found, says:

"Water acts on many oxides, both acid and basic, with great energy and considerable evolution of heat, producing compounds called hydroxides." p. 159.

Under "hydrates" the 1889 edition of Watt's "Dictionary of Chemistry," we read the following:

"Another way of stating the theoretical difference between hydrates and hydroxides is to say that hydrates contain water as such, and that hydroxides contain the elements of water." p. 703, v. 2.

"The term hydroxide is sometimes used in a narrower sense than explained above; by some chemists it is applied only to compounds whose reactions are best explained by supposing them to contain the group or radicle OH." p. 704. Remsen [42] in 1899 supported this view:

". . . the hydroxides form two of the most important classes of compounds, known as acids and bases." p. 61.

Goodchild and Tweney [21] define an hydroxide thus:

"A compound containing the hydroxyl group OH. Hydroxides may be acid or alkaline in character." p. 298.

"Funk and Wagnall's Dictionary" [17] presents this definition:

"A compound containing the group hydroxyl, and formed by the union of the molecules of water, so that a rearrangement of the atoms takes place, yielding hydroxyl." p. 880.

The "Handwörterbuch der Naturwissenschaften," Jena, 1914, is in accord with this view.

"Hydroxyde kennt man Verbindungen welche die einwertige 'Hydroxyl' gruppe—OH enthalten. . . ." v. 5, p. 344.

The definition given by "Webster's" [52] is:

"A compound of an element or radical with hydrogen and oxygen, not regarded as containing water. . . . The term is usually applied, and by many chemists restricted, to compounds containing the group OH, or hydroxyl. Hydroxides may be basic, neutral, or acid, according to the nature of the combining atom or radical. Most hydroxides, commonly so called, however, are basic." p. 1055.

On April 20th of this year "Science" * published a list of rules adopted by the Nomenclature Committee of the American Chemical Society and that of the London Chemical Society in which the following appears:

"The word *hydroxide* should be used for a compound with OH and *hydrate* for a compound with H_2O. Thus, barium hydroxide, Ba $(OH)_2$; chlorine hydrate, Cl_2 10 H_2O."

**Science*, N. S. 57, 474 (1923).

Murray [36] defines hydroxide as:

> "A compound of an element or radical with oxygen and hydrogen, not with water; by some chemists restricted to compounds whose reactions indicate the presence of the group hydroxyl (OH)." p. 491, v. 5.

Mellor [32 33] extends the term to all hydroxyl compounds but recognizes that it is used in the narrower sense where it applies only to basic compounds. In this modified view he is in accord with Silliman.[46] He says:[32]

> "From this point of view water can be regarded as hydrogen hydroxide, H-OH, analogous with K-OH, potassium hydroxide, and Na-OH, sodium hydroxide. Excluding certain carbon compounds, the hydroxides of the non-metallic elements are usually acids, and the hyrdoxides of the metals are usually bases. The term 'hydroxide' is generally reserved for compounds of the basic oxides with water; and the term 'anhydride' is usually reserved for the acid anhydrides." p. 146.

The same idea is repeated in his great "Comprehensive Treatise," [33] and here he insists upon the broadest extension of the term in theory:

> "Every element, excepting fluorine and the argon family, appears to form one or more hydroxides, directly or indirectly." v. 1, p. 395.

Sharply contrasted with these views is that concept of the term hydroxide which today is held by the great majority of chemists, the limitation of the term to those hydroxyl compounds which exhibit basic properties. As I shall show, this view is the original idea expressed by the term and has been held continuously, although obscured and distorted by changing notions of chemical theory, during the past twelve decades. Williamson [53] in 1851 wrote:

> "The experiments of M. Chancel, agreeing in result with my own, have clearly proved that the numerous family designated as hydrated oxides are not formed by the juxtaposition of an atom of water with an atom of metallic oxide, *e. g.*, $K_2O + H_2O$, but that the equivalent of the molecule is half that quantity, namely $\frac{H}{K}O$; they are not

compounds of water but products of substitution in water . . . alcohols, which are truly hydrated oxides, must be considered as products of substitution of the compound radicals, . . . for half the hydrogen of water."

At that time the compound radicals, or, as we should today term them, the alkyl radicals, and the alcohols as well, were considered basic in nature. This work of Williamson first brings out clearly the idea of hydroxyl compounds.

Roscoe [44] in 1873 definitely limits the application of the term:

"Viele basische Oxide verbinden sich mit Wasser zu einem Hydroxide." p. 153.

"Die im Wasser löslichen Hydroxide haben, wie schon früher erwähnt, eine alkalische Reaction." p. 154.

Kolbe [30] concurs in this view:

"The name hydrate includes two classes of bodies; the acid hydrates (the oxy- or sulpho-acids) and the basic hydrates (the hydrates proper)." p. 56.

Nuttall [38] is admirably definite:

"Hydroxide, a metallic hydrate." p. 185.

Richter [43] meets the issue squarely, also:

"Some of the elements yield acids by their union with oxygen, or more correctly oxides, which form acids with water. Most of these are the metalloids. . . . With oxygen the metals usually yield oxides, which form hydroxides (hydrates) or bases with water." p. 84.

The "Century Dictionary" [4] supports this view:

"A metallic or basic radical combined with one or more hydroxyl groups, as potassium hydroxide, KOH; ethyl hydroxide, C_2H_5OH. Hydroxides may be regarded as formed from water (HOH) by the substitution for one of its hydrogen atoms of a metal or basic radical. An acid radical combined with hydroxyl is called an acid, the term hydroxide being reserved for basic compounds." v. 5, p. 2940.

The following quotations are taken from the fourth edition of Roscoe and Schorlemmer's "Treatise on Chemistry":[45]

"The acid-forming oxides combine with water to form hydrates which are termed acids." p. 261, v. 1.

"The basic oxides . . . form in combination with water a class of compounds termed hydroxides or hydrated oxides. . . ." p. 260, v. 1.

These quotations show that since the middle of the last century there have been extant and co-existent three well-defined and distinct concepts of the term hydroxide and that these three views persist to the present time, particularly in textbooks. In order to reach a decision as to which of these three definitions we should accept and which discard let us consider the historical development of the term. In the course of this investigation we shall find it necessary to go back to the very beginning of modern chemical nomenclature and to examine the works of those men who laid the foundations of our science.

The word oxide was coined by a French chemist, de Morveau,[34] in 1787. This man of genius and insight formulated the first scientific system of chemical nomenclature with Lavoisier, Bertholet, and de Fourcroy. He was specific in his definition of the word oxide and the meaning he gave it was generally accepted until the downfall of Berzelius' electro-chemical theory, when chemical theory was thrown into a state of flux and the term oxide was extended to include the ozygen compounds of the non-metals. De Morveau says:

"Nous avons donc dû chercher une expression nouvelle, & pour la rendre conséquent à nos principes, nous avons forme le mot *oxide*, qui d'une part rapelle la substance avec laquelle le métal est uni, qui d'autre part annonce suffisamment que cette combinaison de l'oxigène ne doit pas être confondu avec la combinaison acide, quoiqu'elle s'en raproche à plusiers égards." p. 56.

"Après avoir établi la distinction des acides & des oxides métalliques, c'est-a-dire des métaux oxigène & des métaux simplement oxidés. . . ." p. 58.

The acids are not oxides, according to this statement, but are compounds of oxygen with acid-forming elements. This curious distinction is based upon a difference in function of the resulting compounds and shows clearly the insight of the man in not confounding a similarity in process of preparation with a systematic likeness.

The next event of interest in development of the word hydroxide occurred twelve years after the coining of the term oxide. In 1800 Joseph Louis Proust * devised the word hydrate and applied it to the hydroxides of copper.

> "Le second est une combinaison particulière de l'oxide et d'une quantité fixe d'eau concrète, d'où dépend sa couleur, et que j'ai crû devoir nommer *hydrate de cuivre*." p. 41.

Proust's concept of hydrates is identical with the most limited modern view of hydroxides. Contemporaneous chemists accepted the term and used it in this sense exclusively. The use of hydrate in place of hydroxide still persists at the present time, particularly in England, where the term was readily accepted. Proust had definite ideas about the hydrates; he felt that they were true compounds and, in defending this view, entered into that brilliant controversy with Bertholet which eventually firmly established the law of definite proportions. Proust says:

> "100 parties d'hydrate distilleés donnent 24 parties d'eau, 75 d'oxide noir (of copper), et la valuer d'un grain d'acide carbonique, étranger à cette combinaison, et qui s'y trouve par des causes que nous éclaircirons tout à l'heure." p. 43.
>
> "Dans l'hydrate de cuivre récent, il ne peut exister aucun soupçon d'acide." p. 43.

He subsequently developed the idea and applied the term to other metallic hydroxides.[40] [41] In 1804, in answer to objections, he retorts that in the hydrates the water acts the part of an acid (p. 348), thus anticipating, by eight years, Berzelius, who is generally considered the father of that idea. His notions are well displayed in the following statements:

> "L'hydrate est, comme jel'ai fait voir antérieurement, la combinaison d'un oxide avec l'eau." ". . . je n'hesiterai point à assurer qu'il y a non-seulement des hydrates métalliques, mais même aussi des hydrates alkalines et terreux."
>
> "On ne peut nier aujourd'hui que la chaux ne se combine avec l'eau." p. 347.

Smithson,[47] reporting the analysis of some calamines, uses the term hydrate in accordance with the ideas of Proust:

*"Recherches sur le cuivre," *Ann. de Chim.*, 32, 26-54 (1800).

". . . it seems to consist of two matters; carbonate of zinc, and a peculiar compound of zinc and water, which may be named *hydrate of zinc*." p. 22.

Klaproth and Wolff [28] in 1810 reflect the definite concept of the term:

"Proust first gave the name of hydrate to the combinations of metallic oxides with water." v. 2, p. 518.

John Davy [14] in 1811 refers to "hidrate" of potash and Vogel [49] uses hydrate, both of them in the limited sense that Proust imposed upon the word. Humphry Davy [12 13] did not accept the term, apparently, for he makes no use of it.

The first use of the term hydroxide eluded our search for months. It is evident that it could not have preceded the coining of the word oxide, which occurred in 1787, so with that as a lower limit a search of the literature was initiated which involved the scrutiny of every publication which might conceivably include the word. Cutbush [9] defined the term in 1821 and it was used by Henry [25] in 1823. Then it totally disappears from the literature until 1851, when it reappears in the "Catalogue of the Great Exhibition." [3] It is not used by Kels,[27] Chaptal,[5] Davy,[12 13] Dalton,[10 11] Silliman,[46] Cutbush in 1814,[8] Hare,[24] Gay Lussac,[18 19] d'Aubuisson,[1] Vogel,[49] or Berzelius.[2] These papers cover a period of forty-two years, from 1791 to 1833, and, had the term been in wide use, would undoubtedly have included it.

The word hydroxide was coined in 1802 by Richard Chenevix,[6] who proposed it as a better form than Proust's hydrate, against which Chenevix urged some objections. He says:

"Hydro-oxide had been a much more proper appelation, as it would express the combination not of Hydrogen, but of water; which is the truth." p. 34.

"I have stated before, that Hydro-oxide, or Hydroxide, would be the proper term for all combinations of metallic oxides with water; for such combinations, as Copper, Cobalt, Nickel, and Uranium, are capable of affording." p. 77.

A word concerning this man, now almost forgotten in science, who coined so widely used a term, may not be out of place here. Chenevix was born in Dublin, Ireland, in 1774, and died in Paris in 1830. When twenty-four years of age he pub-

lished his first paper on a chemical subject and for ten years was active in chemistry, publishing twenty-four papers in all until 1808, when he suddenly disappears from scientific literature. In the latter part of his life he was a successful dramatist and novelist.

He evidently did not possess sufficient personal influence to supplant Proust's hydrate with his term, for to the prestige of the professor at Madrid alone can we attribute the long survival of the former term. It was not until a great development in chemical theory and a fundamental change in point of view demanded a revision of our notions of the mechanism of water-combinations that the term hydroxide was firmly established in chemical terminology. Watts,[8] in 1864, and his third supplement, published as late as 1881, do not mention the term. From the start, however, an exemplary definiteness of meaning was attached to the term. Witness Cutbush:[9]

> "Hydro-oxydates. Oxydes combined with water." p. 31.
> "Hydro-oxydes. Oxydes combined with water." p. 31.
> "Hydrate. A chemical combination of a body with water." p. 29.
> "Oxydes. Combinations of oxygen with different bases, not possessing, strictly speaking, acid properties." p. 49.
> "Sulphuric acid. . . . A compound of sulphur and oxygen." p. 73.

and Henry:[25]

> "The compounds of (metallic) oxides and water in which the latter exists in a condensed state, are termed hydrates, or hydro-oxides, or hydroxures." v. 2, p. 42.

In 1851,[3] after a disappearance of nearly thirty years from the literature, it still is used only for basic compounds:

> "The whole coast of Andalusia is rich in galenas; the province of Malaga yields this product mixed with pyritic iron and hydroxidated iron, at Mijar." p. 1326. "13. Hydroxide of iron, from San Claudio." p. 1327. ". . . enveloping the bunches of hydroxide of iron." p. 1328.

These quotations make it clear that, in their original meaning, both of the terms, hydroxide and hydrate, connoted compounds of basic oxides with water or what we should today refer

to as basic hydroxides. The original meaning of the word acid is clear, the oxygen compound which (dissolved in water) possesses acid properties. An acid is not an oxide, de Mourveau,[34] Cutbush,[9] and Hare.[24] The latter says:

> "All the binary combinations of oxygen have been called oxides, when not acid." p. 209.

The correlative term base is equally clear. Cutbush defines it:

> "Base. A term used to express the earth, alkali, or metal, which forms a salt with an acid." p. 12.

The work of Williamson[53] made necessary some stated distinction between classes of compounds in which water exists as such and in which it exists in a rearranged form. The term hydrate was convenient and, although it had been applied by Proust and his contemporaries specifically to what we now term hydroxides, it had gradually been extended to include all compounds of water. Substances which contain water of crystallization, hydrated compounds in which the water is patently present in something more than physical union, and even masses which were merely moistened with hygroscopic water were all subsummed in the category hydrate. This state of affairs was not so serious while the Berzelian notions of chemical theory held the field, but, when the electro-chemical hypothesis was overthrown, the newer ideas demanded more definite conceptions of the character of water of hydration; more specific explanation of the way in which water is combined, and some way of distinguishing between compounds whose water may be readily driven off by heating and those which are unaltered by any heat or only by very high heat.

The hypotheses of acid water and basic water no longer were satisfactory; it was also evident that a great difference exists between water as combined in the alkaline hydroxides and as united in crystalline sodium sulphate. The term hydroxide began to be used again, but with rather indistinct meaning as denoting something in which water is combined more firmly than in the hydrates. Clarke[7] and Perkin[39] attempted to apply physico-chemical tests to compounds to establish a definite distinction between hydrates and hydroxides. The former deter-

mined the specific volumes of a large number of water-compounds, including hydrated salts and alkaline hydroxides. He found that the effect of combined water in the hydrated salts was nearly regular; that the mean value for the molecular volume of each molecule of water of crystallization is 13.76, but that there is no such regularity observed in compounds in which, as we would now say, the hydroxyl group occurs. Perkin measured the magnetic rotatory power of many compounds and their hydrates and came to the conclusion that if hydration increased the rotatory power by about unity the new compound is a hydrate.

The distinction between the two classes of compounds is, however, difficult to draw from such data and considerations. It is far simpler and more satisfactory to decide the question by analysis of the chemical relationships of the substance. Muir was led into the absurdity of deciding that cupric hydroxide is a hydrate, whereas arsenic acid (H_3AsO_4) is an hydroxide [35] by failure to observe this principle.

This mass of evidence may be summarized thus: The terms hydrate and hydroxide were originally synonymous and were specifically applied to basic hydroxides. The acids were not classed as oxides and the chemistry of the alcohols, phenols, and carbohydrates had not been developed, so that there could be no inclusion of these compounds in the concepts. The term acid was confined to those oxygen-compounds which united with bases to form salts and this statement also defined bases as those substances whose combination with acids produced salts.

The original conceptions of hydrates and hydroxides persisted until well past the middle of the last century; the term hydrate being gradually used in a more inclusive sense until, finally, the necessity of discrimination among the compounds of water forced action and the result was a muddling of both notions which has come down to us at the present day and constitutes the problem of this paper.

I think that there will be general agreement today that hydroxides are not to be regarded as water compounds; that type of substances may be characterized by the term hydrate. The characteristic of an hydroxide, then, must be content of hydroxyl, and our definition of the term will depend upon the modifications and limitations which we impose upon this concept.

The most inclusive definition of the term hydroxide is the statement that it denotes a substance which contains an hydroxyl group.

Defined in this way the class hydroxide will contain a very diverse collection of substances. In addition to the metallic hydroxides we shall include the oxy-acids, such as sulphuric acid and phosphoric acid and, of course, we must admit the acid salts, such as sodium bisulphate $NaO.SO_2.OH$, as well as the basic salts. Alcohols, phenols, the enol forms of tautomeric ketones must also be admitted. Resorcin, then, may be termed orthosalicyl hydroxide. All of the organic acids, both the carboxylic and sulphonic acids, belong in this class; we shall term formic and oxalic acids hydroxides. The hydroxy-acids, such as lactic acid, have a double claim to recognition as hydroxides owing to their content of two hydroxyl groups. The hydroxy-amines, hydroxy-pyridines, hydroxy-quinolines, and the derived alkaloids amidst the intricacies of whose constitutional formulas nestles an hydroxyl group, all come clamoring for inclusion. Nor can we bar out that great class of hydroxyl compounds, the carbohydrates from glycollic aldehyde, the simple biose, through the whole class to the complex cellulose, for the carbohydrates bristle with hydroxyl groups.

There are certain difficulties, however, which arise as a result of so wide an extension of the meaning of the term hydroxide. If all these substances are to be considered hydroxides it follows that they must have names in conformance with this aspect of their constitutions. Systematic classification requires this. But an effort to satisfy that demand would lead us into absurdity and cause us to coin a large number of new names which would be of no other service than to bolster the theory. Sulphuric acid must become sulphuryl hydroxide; sulphurous acid, thionyl hydroxide; and what we should name thiosulphuric acid and tetrathionic acid is not very clear. Phosphoric acid would easily become phosphoryl hydroxide; but what should we name hypophosphoric acid? With the alcohols and phenols there would be no more than moderate difficulty; the organic acids, however, would not be so readily disposed of and the carbohydrates would present a problem which is not at all pleasant to contemplate.

A more serious objection to the broad definition arises from the consequences to chemical theory. If we apply the term hydroxide to such a varying and heterogeneous array of substances, the concept hydroxide loses all specificity as a functional mark; it converts the term into a mere character and divests it of all practical value. The far larger portion of the substances enumerated is not chiefly characterized by the content of hydroxyl but the chemical properties depend upon other atomic complexes and the presence or absence of hydroxyl is frequently of very minor importance. The class loses most of its significance and its members no longer possess outstanding common properties.

The extension of the class to include all hydroxyl compounds serves no scientific or practical purpose. If the class cannot be considered a homogeneous unit, and it certainly cannot be so considered if it is to contain acids, bases, and alcohols, which have their own specific properties as classes, the utility of the term for either purpose is much impaired. If the members of the class do not exhibit certain properties which readily identify them as belonging to the category, and all of these various classes enumerated above do not fulfill this requirement, it is impossible to assign definite characters to the class and consequently the significance of the class-term is destroyed.

From such considerations we must conclude that the extension of the term hydroxide to include all hydroxyl-compounds could have but one consequence, the worthlessness of the term. The second idea, that of allowing the term to embrace all hydroxyl-compounds but of restricting its use to basic compounds, does not avoid the objections raised against the other inclusive idea and creates its own objection on the ground of vagueness.

There remains, then, the concept that an hydroxide is an hydroxyl-compound with basic properties. This most limited definition excludes the oxy-acids, the alcohols, the phenols, enol-ketones, organic acids, sulphonic acids, and all the rest of that galaxy admitted by the broad definition.

The first point in favor of this narrow view is the fact that this concept is the one which is held by the greater number of chemists at the present time. This, in itself, is no argument for the correctness of the concept, but it is an important consideration in a case like the present, where the preferableness

of conflicting notions is being studied. It would be easier to get general agreement to this definition than to any other.

Although this narrow definition is supported by the historical data an argument based upon those facts will not be considered of first importance. We cannot consent to bind ourselves to the notions of a hundred and twenty years ago, for we know that those ideas of chemical relationships were inaccurate in the light of our present knowledge. We can, by such evidence, readily demonstrate that the term acid is misused today, and, indeed, that term has had many modifications of meaning since Lavoisier's time; but such an effort could not result in any real benefit to chemical nomenclature. Certainly, no general term is today used with more specificity of meaning than is the word acid. Consequently the historical facts, while important, cannot be considered final reasons for the acceptance of this narrow view.

A more important argument in support of this limited concept, however, is based upon functional relationships. Throughout chemical nomenclature the idea of functional similarities is most important in classification. The acid function is the only property shared in common by all the members of the large, perhaps the largest, chemical classification of substances, the acids. Diverse as their structure may be, various as their components are, differing most widely in physical properties, in solubility, in state of aggregation, yet all producing hydrogen ions under proper circumstances, whence hydrogen ion concentration comes to be the measure of acidity. The possession of this one function classifies the substance as an acid.

Is there a corresponding function which characterizes an hydroxide? Unless we limit the term to the basic hydroxides, those which, when soluble, ionize to radical and hydroxyl ions in solution, it will be difficult to find one single common property among hydroxyl compounds. Reactions with phosphorus halides, which are of broadest application, will not suffice definitely to distinguish them in every case.

It appears likely that the confusion which has arisen out of the idea that oxy-acids are hydroxides is due to lack of just this sort of consideration. This concept apparently had its beginnings at the time when chemical theory decided that water is necessary for the acid function and the natural analogy of

both acidic and basic oxides combining with water to form in the one case acids and in the other bases was too alluring for resistance. This conclusion was brought forward a few years before Arrhenius published its revolutionizing theory; it is quite probable that, had the theory of ionization been accepted first, no acid would ever have been termed an hydroxide. Happening in the other way, however, and in the face of the numerous new ideas consequent upon the electrolytic hypothesis, the study of water combination was neglected and such imperfect ideas as had been formulated were allowed to stand unchallenged.

From no functional point of view, then, can an oxy-acid be considered to fall into the class of hydroxides. On the contrary, the very opposite properties of acids and basic hydroxides indicates fundamental differences in the nature of the combined hydroxyl groups. In the one case the hydroxyl group is split by ionization, its hydrogen appears as hydrion and its oxygen occurs in the anionic portion of the electrolyte. In the basic hydroxides the hydroxyl ionizes as such.

Another fundamental distinction will become apparent if the mechanism of the reaction between ionized water and an acidic oxide is compared with that of ionized water with a basic oxide.

The same argument applies when we consider the alcohols as hydroxides. These, when they ionize, yield hydrogen ions only, never hydroxyl ions. For theoretical reasons they are sometimes considered as basic hydroxides, yet this concept cannot justify itself in the face of critical analysis. Many of the ideas we hold concerning the alcohols are the result of the pedagogical practice of comparing them with the alkaline hydroxides for the sake of impressing the facts of organic chemistry upon our student minds. True, we have a series of "salts" of the alkyl radicals and can match the more important mineral salts with examples from the organic compounds. But it is not difficult to see that there is a fundamental difference between the two classes of substances. Methyl chloride, to consider a well-known alkyl "salt," is no chloride in the sense that sodium chloride is; it does not ionize to form chloride ions until it has first been hydrolyzed. It is rather chloromethane and this is the preferred terminology; the other name is retained for historical and commercial reasons.

In the phenols the hydroxyl group also lacks any basic function and here, when there is any ionization, hydrion and not hydroxyl ion is formed. The replacement of the phenolic hydroxyl by anions does not result in true salts. This is recognized in their nomenclature; we speak now of chlorobenzene, not of phenyl chloride, and of chlorophenol, not of salicyl chloride (which indeed would be a quite different substance).

In the hydroxy organic acids the hydroxyl has no basic functions whatever and the consideration of these compounds as hydroxides would lead to such a cumbrous nomenclature that the Geneva system is much to be preferred. Yet these substances must be included in the class hydroxide unless we are to define it narrowly.

In the nitrogen organic compounds the presence of hydroxyl is always of minor importance. Where the hydroxyl is united with the ring nitrogen we have the pyridinium, quinolinium, etc., bases, which are true basic hydroxides, analogous with ammonium hydroxide. Hydroxyl, substituted in the ring, however, becomes phenolic and is no longer basic. The same situation occurs with those alkaloids which add water to the basic nitrogen atom to form true hydroxides; the hydroxyl so combined functions as an anionic group. When the hydroxyl is combined with carbon in the alkaloidal molecule it functions as a phenolic or as an alcoholic group.

The phenomenon of amphoteric hydroxides appears, at first glance, to present difficulties in the way of limiting the term hydroxide to basic compounds. The hydroxides of aluminium, zinc, chromium, lead, etc., dissolve in acids and in strong alkalies to form, in the one event, salts of the metal, and in the other, compounds which have been considered metallic aluminates, zincates, chromites, plumbates, and so on. Creighton * has just reported the formation of metallic salts of cupric acid by the solution of cupric hydroxide in strong alkalies. As representative of this class of phenomena, with the possible exception of the last case, let us consider the case of aluminium hydroxide.

From the evidence it might be argued that aluminium hydroxide may behave either as an acid or as a base and, indeed, the term "amphoteric" was coined to describe just this condition.

*J. Am. Chem. Soc., 45, 1237 (1923).

If there is any validity in such an argument we must postulate the dissociation of aluminium hydroxide in solution, however slight the concentration may be, into not only hydrogen and hydroxide ions, but into aluminium and aluminate ions. The mere statement of the logical consequences of the idea at once demonstrates that it is preposterous. No one will today question the conditions which follow the solution of aluminium hydroxide in strong acid. There is agreement that this process is analogous to the solution of any metallic hydroxide in a strong acid. This settles the question of the basic behavior of aluminium hydroxide. What, then, shall we say about the solution of this substance in strong alkalies? If it develops an acid function we must postulate dissociation of hydrogen; if we wish to escape from this absurdity we are forced to deny the actual formation of sodium aluminate.

This is not, of course, the impasse that it appears to be. The way out of the difficulty lies in a criticism of our use of the word solution in this connection, and when we carefully consider this point we see at once that we cannot view the acid and alkaline "solutions" of aluminium hydroxide as qualitatively similar. There need be no question of hydrogen ion formation here at all, for we are really dealing with a two-phase system in which micels of aluminium hydroxide surrounded with an envelope of adsorbed sodium ions form the dispersed phase. In other words, the system belongs to colloid chemistry and considerations of the formation of a sodium salt are quite beside the point. Aluminium hydroxide is a base, a weak base, to be sure, but a base, nevertheless, and it is peptized by sodium hydroxide.

The same reasoning may be applied to the "amphoteric" hydroxides of zinc, chromium, and lead, which are dispersed in alkaline solutions and which the older chemistry considered might form compounds known as zincates, chromites, and plumbates. The case of cupric acid cannot, according to Creighton, be disposed of in this way, yet he makes no assumption of the dissociation of cupric hydroxide to form hydrogen ions, assuming, rather, that the cuprate ion receives its two negative charges from negative hydroxl ions. This view cannot, of course, affect the truly basic character of cupric hydroxide.

But if we are to limit the term hydroxide to basic compounds, what term shall we use to designate the larger class in-

cluded in the broader definition of the word? If we must have some way of designating all substances which contain hydroxyl groups, they may conveniently be referred to as hydroxyl compounds. This, indeed, describes them much better than the term hydroxide, for the first phrase refers definitely to a structural similarity just as the phrases carbon-compounds, nitrogen-compounds, or sulpho-compounds, do, and without binding us to any specific statement as to functional characteristics.

On the contrary, it may be urged that the term bases is sufficient for the basic hydroxides, and with some show of reason. The term base may, however, include substances which do not contain hydroxyl groups and which do not react with water to form them. Witness the "onium" bases, many of which do not form OH.

From all these considerations it appears that the greatest practical as well as scientific utility will be served by the limited concept of the term hydroxide.

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ABSTRACTED AND REPRINTED ARTICLES

THE CENTENARY OF THE PHILADELPHIA COLLEGE OF PHARMACY.*

Institutions, of whatever kind, are in part the resultants, and in part the formative factors of the system of civilisation to which they belong. If the external forces acting upon them preponderate, they are apt to become stereotyped as in some of the ancient civilisations of the East. If the internal forces are active and efficient, the institution acquires or retains momentum enough to carry it onwards with acceleration. And rising from a survey of the portly and handsome volume in which are fully recorded all phases of the history of the Philadelphia College of Pharmacy during the hundred years from 1821 to 1921, we can honestly testify that as an institution it has won a place in the second of the two categories we have indicated. This centenary souvenir, which is a monumental work, alike in bulk and subject-matter, is entitled "The First Century of the Philadelphia College of Pharmacy, 1821-1921," and was compiled by a committee under the chairmanship of the editor, Joseph W. England, who is well known by reputation on this side of the Atlantic. Their task was a formidable and laborious one, but it has been discharged with praiseworthy discrimination and workmanlike thoroughness and finish. We owe the receipt of a copy of the book, which was published in October, 1922, to the courtesy of the present President of the College, Surgeon-General W. C. Braisted (formerly of the United States Navy), and we would fain say more about it than our space will permit; but as our copy is to be passed on to the Society's Library in London, such of our readers as would like to handle it for themselves, can obtain it from that quarter. As outlined in the Preface, the purview of the volume comprises Philadelphia and Pharmacy in 1821; the founding of the College chiefly on the initiative of members of the Society of Friends, a body that has always been active in the promotion of all forms of education; the pioneer work in pharmacy of Wood, a New Jersey Quaker, with a medical degree, who became lecturer on chemistry in the

*Reprinted from *Pharm. Jour.*, London, England.

College in 1822, and later Professor of Materia Medica and Pharmacy, and Franklin Bache, a great-grandson of Benjamin Franklin, also a medical man, who in 1831 was appointed lecturer in chemistry in the College; the development of higher ethical and professional standards, and the advent of the U. S. Pharmacopœia, largely the work of pharmacists, and of the American Pharmaceutical Association, and the progress in all its departments and ramifications of the College, during the second half-century of its existence. The book is profusely illustrated with views of the different buildings in which the College has been housed, of "landmark" edifices and pharmacies in the Philadelphia of 1821; with *facsimiles* of indentures, minute-books, students' lecture tickets, title-pages of price-lists, and patent medicine formularies, certificates of qualification (of a chaste artistic design), the title-page and other pages of the first U. S. Pharmacopœia, chemists' labels, the medals presented to students and graduates who served in the Great War, the tablet erected in the College in memory of the students and graduates who served in or perished in the war, and hundreds of portraits of past and present officers, trustees, "executives," and members of the Faculty of the College. It is sometimes said that the history of a country is the history of its great men, but this is only a half-truth, although not necessarily in Tennyson's category of "the blackest of lies." It is undeniable that in the annals of the Philadelphia College of Pharmacy its eminent men have played a predominant part, and also in the development of American pharmacy in general. Of the long list of these the most outstanding names are those of Edward Parrish, whose name is given to the syrup for which he devised the original formula; John M. Maisch, a pharmacognosist of the first magnitude and the author of the once standard text-book of "Organic Materia Medica"; Benjamin T. Fairchild, of Fairchild Bros. and Foster; Joseph P. Remington, Samuel P. Sadtler, Frederick B. Power (Hanbury Medallist), Henry Kraemer, Harvey W. Wiley (formerly Chief Chemist, U. S. Department of Agriculture and protagonist of the movement which culminated in the passing of the Federal Food and Drugs Act of 1908), Caswell A. Mayo (formerly editor of the *American Druggist*), E. G. Eberle (editor of the *Journal of the American Pharmaceutical Association*), Henry S. Wellcome (of Burroughs and Wellcome, founder and maintainer of the Wellcome Historical Medical Museum, London, Hon. Master in Pharmacy of the College), John Uri Lloyd, a prolific worker in

and writer on pharmaceutical subjects; George M. Beringer (formerly editor of the AMERICAN JOURNAL OF PHARMACY), Edward Kremers (director of Pharmaceutical Experiment Station, Michigan University), Henry V. Arny (author of "Principles of Pharmacy" and research worker in phyto-chemistry and in colorimetric tests and colour standardisation), Charles H. LaWall (Remington's successor in the chair of the Theory and Practice of Pharmacy, and Dean of Pharmacy, and Chairman of the Faculty), E. F. Fullerton Cook (Professor of Operative Pharmacy and Director of Pharmaceutical Laboratory and Chairman of the U. S. Pharmacopœia Revision Committee), and Ivor Griffith (editor of the AMERICAN JOURNAL OF PHARMACY). Other noteworthy contents of this unique volume comprise a narrative of the original work of the Alumni Association of the College, by means of which graduates are kept in touch with one another and their *Alma Mater;* an historical sketch of the AMERICAN JOURNAL OF PHARMACY, the official organ of the College, in which there have been published many valuable scientific memoirs on original research in pharmacy; a full report of the centennial celebrations in 1921, and a biographical list of graduates (1826-1916) of the College and of the Department of Pharmacy and Chemistry of the Medico-Chirurgical College, which was merged with the College of Pharmacy in 1916. On a rough estimate, this list contains over 7000 names. All that the record discloses as to many of the graduates is the date of graduation and the title of his or her thesis, but in a considerable number of cases the biographical notes show that the graduates got on in life creditably, or with distinction to themselves and honour to their old College. It is impossible, within the limits set for us, to give any adequate description of the many side activities and far-reaching influences of the Philadelphia College of Pharmacy, as partly revealed in the work under review. The College has touched pharmaceutical thought and action at so many points that there is no *calculus* by which we can integrate all the intellectual and moral vibrations which have radiated from this centre of enlightenment and instruction. We rejoice to know that in virtue of the schemes now being set in motion for the enlargement of the sphere of all departments of the work of the College, in premises better adapted for present-day requirements in teaching and research, there is every prospect that in the second century of its history, upon which it has now entered, whilst it may be difficult to do so, the College will surpass the record of its first hundred years. It is a renewed proof of the high ethical standard

and ideals established and cherished by its worthy Quaker founders that one prominent feature of the present-day work of the College should be a course of popular lectures designed to educate the public as to the practical value and beneficence of the sciences in everyday life, and that its developmental scheme should so fully recognise, and make provision for the service of pharmacy to the public health, and welfare of the community, and by and through it of the nations not only of the American Continent, but of the whole wide world. All honour to the Philadelphia College of Pharmacy for its fruitful and inspiring past, and may all good fortune attend it in the fulfillment of its progressive plans for the future!

THE ONE-HUNDREDTH ANNUAL COMMENCEMENT OF THE PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE.

The one-hundredth annual commencement of the Philadelphia College of Pharmacy and Science was held Wednesday morning, June 6, in the American Academy of Music, Broad and Locust Streets, friends and relatives of the nearly three hundred graduates filling the immense auditorium. The address to the graduates was delivered by Albert Linday Rowland, Ph. D., of the Pennsylvania Department of Public Instruction, who functioned in the unavoidable absence of Dr. Finegan, the State Superintendent. Dr. Rowland's impressive and superbly rendered address will long live in the minds of those who were privileged to listen to and understand his message. The Philharmonic Orchestra well cared for the musical part of the program. Degrees were conferred by Dr. Braisted, the President of the College, and were as follows:

Master in Pharmacy (Ph. M.)
(Honoris Causa)
John Coleman, Ph. G.
Henry C. Christensen
H. Lionel Meredith, P. D.

Master in Pharmacy (Ph. M.)
(In Course)
Joseph W. E. Harrison, P. D.

Bachelor of Science in Pharmacy (B. Sc.)

Coffill, George Boyson
Conroy, James Maurice
Liu, Ju Chiang
Sless, Simon Isaac
Trossman, Henry

Bachelor of Science in Pharmacy and Chemistry (B. Sc.)

Engstrom, Harold John
Palomeque, Eduardo
Ramanuskas, Peter Paul

Bachelor in Pharmacy (Phar. B.)

Amin, Hossein
Greengross, Morris
Molitch, Matthew
Zebalsky, Benjamin

Pharmaceutical Chemist (Ph. C.)

Greenblatt, Jacob
Toy, Wing

Graduate in Pharmacy (Ph. G.)

Adelman, Morris
Albert, Bernard
Apelian, Diran H.
Batoff, Ida Lillian
Bergstresser, Titus M.
Beward, Jefferson M.
Bird, Harry Freeman
Blitzstein, Isadore
Bloss, Albert Lafe, Jr.
Bowen, Charles I.
Brandiff, Raymond F.
Brenner, Melchoir R.
Brooks, Meredith H.
Brown, Nathan M.
Capehart, Lovelace B.
Caplan, David Maxwell
Chatkin, Robert
Cheskis, Samuel B.
Cliffe, Albert, Jr.
Coleman, Nathan
Compton, Arman S.
Cooper, John Elwood
Cooper, Richard
Cumpiano, Laura
Danielson, Carl Leon
Detwiler, Roy Witmer
Drell, Tulla
Dubin, Morris
Eisenberg, Nathan
Elkins, Louis
Engle, Clarke Ernest
Ensminger, Margaret J.
Epstein, Harry
Eskin, Samuel
Evans, Charles Smith
Evans, Maurice Joseph
Featherman, Oscar G.
Ferrero, Manuel
Fisher, Albert
Fogletto, Edward
Ford, Joseph John
Freeman, David
Freeman, Dinah
Friedman, Jacob
Friedman, Max Dietz
Frye, Franklin Lamar

Fudala, George M.
Gallo, Vincent A.
Gearhart, James H.
Gilbert, Bernard
Goldblum, Solomon
Goldenberg, Nathan
Golland, Jules
Gomez, Raul
Gordon, Maurice
Graff, Robert Solomon
Green, Pauline
Greenberg, Jacob
Greenberg, William
Griffith, Morris John
Hahn, Joseph Samuel
Hain, Horace Abraham
Handloff, Jacob
Harris, Emanuel
Hayman, Albin A.
Herman, Manya
Herskowitz, Julius
Hilmy, Abdel Kader
Himmelberger, Paul F.
Hutchins, Harold Watt
Jacobson, Simon
Jacoby, Francis A.
Jeter, Frederic Royer
Johnson, Karl Sutton
Julian, Raymond A.
Kanter, William
Katinsky, Nathan
Kellar, Hyman
Keller, Donald Seip
Kendall, Lewis
Kerman, Nathaniel H.
Konefsky, Abraham L.
Kramer, Irving
Kreitzer, Isadore G.
Lachman, Abraham
Leopold, Nathaniel R.
Levin, Nathaniel M.
Lichtenbaum, Manuel
Lieber, Harry
Litt, Samuel C.
Lobel, Abe
Loughrey, Joseph A.
Lowrey, Allen B.
McBride, Charles Wm.
McCreary, Wm. R.
McCullough, Thos. H.
McNelis, Hugh Leo
Malamut, Anna
Margolis, Benjamin
Margolis, Reuben S.
Martin, Robert Carter
Matz, Abraham
Mellanof, Isadore
Miller, Earl Wagner
Minzes, Isadore
Mohr, John Nevin
Morrissey, Leo Cyril
Morrison, James R.
Mosteller, James A.
Mundell, John
Murphy, Anna Regina
Nevers, Effie A.
Nichols, Bernard
Patler, Louis
Paul, Arthur
Pierro, Joseph A.
Pood, Isaac
Rinehart, George F.
Robin, Samuel B.
Roman, Samuel
Roth, Samuel Albert
Rudolph, Rubin H.
Schmickle, Wm. A.
Schwartz, Harry
Schwartz, Jos. Lewis
Scott, Frederic I.

Shafer, Wm. H.
Sharp, Milbron T.
Shoemaker, Philip M.
Shor, Herman Sylvan
Simons, Louis
Sitman, William, Jr.
Smithgall, Frank
Snyder, David A.
Sofronski, Irvin I.
Sovel, Lewis Saul
Spielman, Leon Adolph
Spivak, Mollie
Stanford, Wesley L.
Staub, Harold F.
Stein, Nathan
Stern, Harry F.
Swartz, Kathleen
Tatcher, Ernest
Tickner, Louis
Trout, Valery Jones
Varga, George
Waldman, Simon
Waldo, Herman
Weiman, Edward I.
Weiss, David
Weyman, Bessie E. S.
Wharry, William B.
Winzer, Herman F.

Students Who Have Completed the Scholastic Requirements of the Course and Will Receive Their Diploma Upon Reaching their Majority:

Adams, Weete Joseph
Ameisen, Herbert A.
Armstrong, Robert J.
Beck, Morris Mitchell
Blumberg, Leon
Brown, Alexander M.
Hamilton, Donald G.
Heckman, George H.
Keyser, Samuel F.
Koser, Carl Egle
Lipkin, Miriam
Loser, Wm. Joseph
McCarthy, Charles E.
Miller, Lawrence L.
Sendrow, Benjamin
Silverman, Max
Spengler, Melvin B.
Wiseman, Asiel E.
Wooten, James R.

Students Who Have Completed the Scholastic Requirements of the Course and Will be Eligible for the Degree of Graduate in Pharmacy When Other Graduation Requirements Shall Have Been Met:

Alaburda, Robert
Balliet, Walter David
Bard, Percy Rutt
Becker, Blanche M.
Berman, Robert R.
Bloom, Mary
Bossart, Ruth A.
Brodwater, Charles W.
Caplan, Mosby
Cohen, Maxwell M.
Coombe, R. Victor
Diehm, Lloyd Ruhl

Fenton, John Thomas
Fineman, Cecelia
Flickinger, Wilbur J.
Frank, Adam
Gever, David
Greenberg, Harry E.
Grieb, Carolyn Ruth
Grobman, Isadore L.
Hirsh, Maurice
Keiser, Herald D.
Kelley, Katherine F.
Kester, Ray Ross
Klaiman, George
Levine, Harry David
LeWine, Hymen
Long, William James
Malick, Richard W.
Marr, Frances H.
Minicozzi, Michael Jos.
Molitz, Harry Charles
Monroe, Wm. Henry
Morgan, Aston H., Jr.
Moss, Harry
Orloff, Benjamin
Poust, Kenneth D.
Reese, Margaret Ruth
Riblett, Carlos W.
Rosen, Samuel
Rosenfeld, Irvin
Sclarowitz, Lillian
Scott, John Clyde
Shechter, William
Sherman, Abraham V.
Sklar, Lillian
Steinberg, Israel
Stutman, Samuel
Thornton, Wm. Chas.
Tomalunas, Albert R.
Wasserman, Leon
Yulsman, David

Certificate in Technical Chemistry.

(Three Year Course)

Kohen, Morris
Pike, Frederick A.
Rager, Carroll A.
Steen, Raymond A.

Students Who Have Qualified for Special Certificates.

Bacteriology

Bailey, T. E., Ph. G.
Ballard, James F.
Bonow, Samuel
Corr, Helen M.
Davis, Aaron
Taylor, Harry J.

Clinical Chemistry

Bailey, T. E., Ph. G.
Bonow, Samuel
Friedman, Ida M.

Physiological Assaying

Armstrong, R. J.
Mohr, John Nevin
Mellanof, Isadore
Roderick, John A.
Wasserman, Leon

Perfumery and Cosmetics

Amico, Demetrio
Lichtenbaum, Manuel
Lichtin, Aaron, Ph. G.
Long, William James
Yanagi, Tadashi

Countries and States Represented.

Panama, R. P.	1	Egypt	3
Pennsylvania	152	Cuba	2
Ohio	3	Mexico	1
New Jersey	18	Russia	43
New York	8	Porto Rico	1
Virginia	2	Spain	1
China	2	Austria	1
Ireland	1	Maryland	3
Syria	1	North Wales	1
Roumania	2	Hungary	1
North Carolina	1	Tennessee	2
England	3	Italy	1
Illinois	2	Japan	1
Massachusetts	2	New Hampshire	1
Germany	1	Greece	1
Louisiana	1		
Texas	2	Total	265

AWARD OF PRIZES, 1923.

Presentation of the Howard B. French Cup to the Graduating Class of 1923.

Presentation of the Martin Cup to the Graduating Class of 1923.

(Awarded to and held by a class until a succeeding class attains a higher general average.)

Graduate in Pharmacy (Ph. G.) Course.

Distinguished

Bernard Albert
Abraham Victor Sherman
Albert Ralph Tomalunas

Meritorious

Weete Joseph Adams
Percy Rutt Bard
Blanche M. Becker
Robert Rubye Berman
Albert Lafe Bloss, Jr.
David Maxwell Caplan
Nathan Coleman
Armon S. Compton
Nathan Eisenberg
Harry Epstein
Oscar George Featherman
Manuel Ferrero
John Joseph Ford
Jacob Friedman
David Gever
Bernard Gilbert
Solomon Goldblum
Nathan Goldenberg
Raul Gomez
Isadore Leonard Grobman
Horace Abraham Hahn
Simon Louis Jacobson
Hyman Kellar
Nathaniel Harry Kerman
George Klaiman
Abraham Louis Konefsky
Abraham Lachman
Nathaniel Richard Leopold
Nathaniel Martin Levin
Isadore Mellanof
Harry Moss
Bernard Nichols
Benjamin Orloff
Joseph Anthony Pierro
Isaac Pood
Kenneth Delanson Poust
Irvin Rosenfeld
Harry Schwartz
Louis Simons
Israel Steinberg
Harry Frederick Stern
George Varga
Herman Waldo
Edward Irving Weiman
Bessie E. Shane Weyman

The **Procter Prize,** a gold medal and certificate, for the highest general average of the class, is awarded to

Bernard Albert

The **William B. Webb Memorial Prize,** a gold medal and certificate, offered for the highest general average in the branches of Operative Pharmacy, Analytical Chemistry and Pharmacognosy, is awarded to

George Varga

Honorable Mention

R. Victor Coombe
Manya Herman
Joseph Anthony Pierro
Harry Schwartz
Herman Waldo

The **Remington Memorial Prize,** $20.00, offered by the Estate of Professor Joseph P. Remington, for the highest general average in the examinations in Operative Pharmacy and Dispensing, is awarded to

Leon Adolph Spielman

Honorable Mention

Charles S. Evans
Jacob Friedman
Harold W. Hutchins
Samuel Louis Jacobson
Donald Seip Keller
James R. Morrisson
Israel Steinberg

The **Frank Gibbs Ryan Prize,** a gold medal endowed by the class of 1884 as a memorial to their distinguished classmate, for the best average in the Chemical and Pharmaceutical Laboratory courses, is awarded to

Abraham Victor Sherman

Honorable Mention

Raymond Frank Brandiff
Margaret Jean Ensminger
George Henry Heckman
Harry Schwartz

The **Upsilon Sigma Phi Fraternity Prize,** $25.00, for any outstanding service of particular benefit to the student body and the College, is awarded to

Nathaniel M. Levin

The **Mahlon N. Kline Pharmacy Prize,** a Troemner Prescription Balance, offered by the Mahlon N. Kline Estate, for the highest average in Theory and Practice of Pharmacy, is awarded to

Bernard Albert

The **Bacteriology Prize,** $25.00, offered by the H. K. Mulford Company, for the highest general average in Bacteriology and Serum Therapy, is awarded to

Bernard Nichols

Honorable Mention

Bernard Albert
Solomon Goldblum
Paul F. Himmelberger
Simon L. Jacobson
George Klaiman
Isadore Mellanof
Arthur Paul
Herman Waldo
Bessie E. Shane Weyman

The Pharmacy Review Prize, one year's membership in the American Pharmaceutical Association, offered by Ivor Griffith, Ph. M., for the highest general average in Theory and Practice of Pharmacy in the Senior Year, is awarded to

Bernard Albert

Business Administration Prize, $20.00, offered by Professors E. Fullerton Cook, Robert Fischelis, Howard Kirk and C. A. Wesp, for the highest general average in Commercial Pharmacy, is awarded to

Bernard Albert

Honorable Mention

Simon Jacobson
Ray R. Kester
Louis Tickner
Herman Waldo

Prizes foi Post-Graduate Courses.

The **Advanced Pharmacy Prize,** ten dollars' worth of books, offered by Professor Charles H. LaWall, for the highest grade in Advanced Pharmacy in either the Ph. C. or the Phar. B. Course, is awarded to

Jacob Greenblatt

Honorable Mention

James M. Conroy
Simon I. Sless
Ju Chiang Liu

The **J. B. Moore Memorial Prize,** $25.00 in gold, offered by the Rev. J. J. Joyce Moore and Mrs. H. H. Watkins, Jr., in memory of their father, J. B. Moore, to the member of the graduating class presenting the best thesis representing work in the Department of the Pharmacy is awarded to

Hosein Amin

The **Chemical Control Prize,** a year's membership in the American Chemical Society, offered by Professor Charles E. Vanderkleed, for the highest general average in Chemical Control in the Third Year of either the Ph. C. or the Technical Chemistry Course, is awarded to

Henry Trossman

Honorable Mention

James M. Conroy Morris Kohen

Prizes Awarded by the Alumni Association.

The **Alumni Gold Medal,** for the highest general average for all branches in the Senior year, is awarded to

Bernard Albert

The **Alumni Prize Certificates,** for the highest general average in individual branches in the Senior year, are awarded as follows:

Pharmacy	to	Bernard Albert
Materia Medica	to	Bernard Nichols
Analytical Chemistry	to	Samuel Roman
General Chemistry	to	Bernard Albert
Operative Pharmacy	to	Kenneth D. Poust
Pharmacognosy	to	George Varga
Commercial Pharmacy	to	Bernard Albert

Prize Awarded to Under-Graduate Students.

The **Alumni Silver Medal,** offered by the Alumni Association, for the highest average in all branches in the Junior Year, is awarded to

David Klebanoff Pierce Tomlin, Jr.

And so ended the ceremony which fulfilled the hopes of many young hearts and which marked the end of carefree school days and the commencement of careers of, let us hope, honest service.

SCIENTIFIC AND TECHNICAL ABSTRACTS

THE TRUE OIL-BEARING MILKWEEDS.—Note was made in a recent issue of this journal of the extraction of oil from the seeds of several species of *Asclepias,* commonly known as milkweeds. The note was based on an article in the *Bull. d. Mat. Gras.* of Marseilles. It appears that the editor of that publication was misled by the term milkweed, and that the plant from which the oil is obtained is the Mexican poppy, *Argemone mexicana.* This is a member of the Papaveraceae, the family to which the opium plant and the now famous Flanders poppy belong. Many of the plants of this group have a milky juice, so that they may be called milkweeds in some localities. In some species, however, the juice is highly colored, as in the common Celandine. The account given by the French journal was probably taken from Spanish sources. An abstract in English is given in the initial number of the new series of the *International Review of Science and Practice of Agriculture,* p. 216. The constants of the oil are given in detail.

H. L.

MAKING NEW PHOSPHORESCENT SALT. *Scien. Amer.,* May, 1923.—A new process has been devised for making zinc sulfide. This compound is used for many purposes for which phosphorescent salts are utilized. Equal weights of pure zinc sulfate and sodium acetate are dissolved in hot water. A stream of hydrogen sulfide is allowed to flow through the solution which is kept hot until the zinc is completely precipitated. After the zinc sulfide has settled, the supernatant liquid is removed by siphoning. The sulfide is next washed with hot water by decantation. It is then filtered, and washed thoroughly again and then dried on a water bath. About 200 parts of the zinc sulfide, as above prepared, is uniformly moistened with a solution containing 20 parts of magnesium chloride, 10 parts calcium chloride, 10 parts strontium chloride and 10 parts of crystallized barium chloride, all being dissolved in 22 parts of water. Before this solution is added

to the zinc sulfide it is mixed with 10 parts of a solution of ammonium tungstate, which contains 0.004 gram of the salt per cubic centimeter. The mixture of the prepared chloride solution and the zinc sulfide is evaporated to dryness on the water bath with constant agitation, and the dried mass is then transferred to a crucible and heated in a gas muffle furnace. The heat should be applied gradually so that it requires about one hour for the crucible to become red hot. The crucible should be maintained at this temperature for 30-40 minutes and then allowed to cool to room temperature in the oven. The soluble salts are removed by decantation and washing with water. The washed sulfide of zinc is then dried on the water bath.

(Through *Lefax*) H. C. P.

PLANT RESOURCES FOR MOTOR FUEL.—Under this title, the *International Review of Science and Practice of Agriculture* (n. s., 1923, I, 208) collects the results of study of nine articles that have recently appeared, giving data of the practicability of the manufacture of alcohol for motor purposes. H. I. Cole, chemist to the Bur. of Sci., Manila, P. I., treats at length of the experiments undertaken in the Islands to ascertain the comparative economy of manufacturing alcohol from several of the raw materials there available, and reports that the Nipa palm (*Nipa fruticans Wurmb.*) and blackstrap molasses offer the best and cheapest methods. Alcohol has several advantages as a motor fuel. It burns clean—without carbon deposit, the running of the engine is smoother than with the common hydrocarbon fuels, it stands high initial compression without knocking, lubrication difficulties are less, and, as far as observed, no corrosion has appeared in the valves, and no acid in the exhaust. Certain difficulties will doubtless disappear after further experience.

Mixtures of alcohol with other combustibles have given better results than alcohol alone. In South Africa, a mixture termed "natalite" (55 per cent. of rectified alcohol, 44.9 per cent. of ether, 1.11 per cent. kerosene and 0.56 per cent. of pyridin) has been successful. The percentages are doubtless by volume. Important data are given as to the cost of making alcohol in the Philippines, based upon large experience. The estimated daily cost of operating a plant producing 1000 gallons per day is $138.29, which is about

14 cents per gallon. The figures include labor, fuel, interest, depreciation, etc. Unless the "etc." includes the cost of the material, which does not seem likely, the actual cost per gallon will be higher than that calculated from the above total. It is not stated what strength of alcohol is produced, but presumably the calculations are made on the 95 per cent. basis. The Nipa palm is stated to be the most important and cheapest source of alcohol, as the plant grows in uncultivated places and the sap is drawn from near the ground, thus obviating the necessity of climbing. The alcoholic product of this plant has, however, been heretofore mostly employed as a beverage, and its applicability as a fuel has only recently been put to the test. The sap passes quickly into fermentation, usually arriving at the distillery with an appreciable alcohol content, though complete fermentation requires considerable time. To prevent loss by conversion into acetic acid, a mixture of the sap with molasses is usually employed. At present the palm is found extensively distributed in the Philippines and North Borneo, some 400,000 acres being estimated as covered by it.

Vegetable oils have been studied as materials for motor fuel. The investigation has been initiated on account of the danger of using the inflammable hydrocarbons in a hot climate. The ordinary vegetable oils are stated to be applicable to motors of the Diesel and semi-Deisel type. For engines of the latter type, experiments in Europe have shown that palm oil may be used as fuel without any serious modification of the engine details. The calories of vegetable oils are, of course, high. The possibility of corrosion owing to the fact that palm oil has high acidity seems to have been eliminated by the experiments.

The motor vehicle problem becomes of great importance in districts like South Africa in which the tsetse fly interferes with raising of draft animals. The possibility of using the native products for fuel will be of great advantage. The high prices for the hydrocarbon fuels, with the likelihood that these will not be materially reduced in the future, constitute important reasons for experiment along the lines indicated in the article. Up to the present, investigations have centered on palm oil, but it is to be hoped that a much wider range of experiment may be soon undertaken. The substitution of such materials as alcohol or fixed oils would have the great advantage of eliminating to a large extent the fire-risk that is now associated with the hydrocarbon fuels.

H. L.

Compositions and Properties of the Commercial Arsenates.—Immense amounts of arsenic compounds are used in spraying plants for protection against insects and fungi. In 1920 over 11,000 tons of arsenous oxide were produced in the United States, more than half of which was used in the manufacture of insecticides. The principal compounds used for such purposes are arsenates, those containing lead, zinc, calcium and magnesium being the most important. An elaborate study of the composition and properties of the commercial forms has been made by F. C. Cook of the Bureau of Chemistry and N. E. McIndoo of the Bureau of Entomology. The results appear in Bull. 1147 of the Department of Agriculture. The investigation included experiments on feeding larva with materials impregnated with arsenic. Considerable difference was found in the susceptibility of different species. The maximum amount of arsenic (As) required to kill a honeybee is 0.0005 mg., but the toxic dose for a full-grown silkworm is 0.0273 mg. It is to be noted, however, that the honeybee, confined in cases, retains the whole of the arsenic compound taken, whereas the silkworm expels most of it. Lead arsenate is one of the most-used compounds. The common form, $PbHAsO_4$, is well standardized and stable. The commercial calcium arsenate contains more calcium that is required for a strictly tribasic salt. A sample of copper barium arsenate, made in the laboratory, was found to have strong insecticide properties.

H. L.

Increasing Rubber Output.—Oil and rubber are two of the most important world staples at the present time and struggles to obtain control of regions in which they may be obtained are disturbing the diplomatic relations of the great nations. A wonderful increase of rubber supply has resulted from the cultivated plants, just as the supply of quinine has been increased by the cultivation of the cinchona trees. Apart from the advantage of extending the area in which a given plant grows is the improvement of the strain so as to secure a greater yield or to develop individuals less subject to damage from weather conditions or enemies. The growth of the plantation rubber industry is shown by figures given in Tuttle's recent book on the "Analysis of Rubber." In 1903, 25 tons was the output of plantation rubber, but in 1919, 360,000 tons were produced. Many plants carry milk juices, technically called

"latex," but only a few so far known are of commercial value. *Hevea brasiliensis* Muell. Arg. is the most important source. The issue of the *India Rubber World* for May, 1923, gives an interesting and detailed account of methods of bud-grafting for improving the yield of latex. Investigations in some plantations showed that a considerable proportion of trees yielded but little of the desired material, while other trees were fruitful. At present the average production is about five pounds per tree per year, but instances of as much as ten times this yield have been observed. From analogy of other plans it would seem that the grafting of buds of the high-yielding trees upon one-year seedlings would insure the development of a high-grade stock, and some experiments lately undertaken in the Dutch East Indies have been sufficiently encouraging to warrant more extended work.

In the issue of the *India Rubber World* from which the above note is taken the article is by G. E. Perry, presenting the histology of the *H. brasiliensis,* liberally illustrated. Mr. Perry, who is a graduate of the Mass. Agricultural College, spent several years in the rubber-producing regions. At present only a small area of bud-grafted plants is under cultivation.

H. L.

SOLID EXTRACTS

Dr. Theiler, writing in a German chemical journal states that pure methanol (wood or methyl alcohol) is entirely non-poisonous. The impure spirit has well-known poisonous properties, but these are stated to be due to the impurities which it contains such as allyl alcohol, allyl hydrate and acetone and their homologues. Freed from these impurities methyl alcohol is stated to be harmless.

On the other hand a Harvard pharmacologist states that wood alcohol instead of being changed into harmless substances which are easily eliminated, remains in the body as such for a considerable time, and is then slowly converted into another poison, formic acid, the acid which is found in ants. These poisons, and perhaps a third formed from the wood alcohol, formaldehyde, attack the brain and other organs and cause death or blindness. Poisonousness is an inherent quality of wood alcohol. It is as impossible to prepare non-poisonous wood alcohol as it is to prepare non-poisonous prussic acid. Individuals vary considerably in their susceptibility to wood alcohol, some die or become blind from amounts

which seem to do no harm to others. This is true, however, of all poisons. Death or blindness has resulted from two teaspoonfuls and from one or two tablespoonfuls of the poison. Sixty to seventy-five per cent. of those taking four ounces—that is, a quarter of a pint or half a "glassful"—have died or become permanently blind.

Now, then, we take another paragraph to state, that we do not care particularly which of the foregoing paragraphs is scientifically correct. As a matter of fact,

"When doctors can't agree
How can we poor mortals see!"

But inherent caution still bids us place our wholehearted confidence in the statement of the toxic nature of wood alcohol. We are not able to surmise just how an article with such a bad reputation can be pure.

The first printed books had to be sold as manuscripts, because of the prejudice against printing. The learned men of Italy sneered at the invention as a barbarous German innovation.

The first shipload of saltpeter sent to England from Chile could not find a buyer and had to be thrown into the sea.

The first bananas shipped to London could not be sold at any price, or even given away in the slums, but were left to rot because nobody would eat them.

When they were first introduced into England potatoes were denounced as injurious to society and tomatoes as injurious to morality.

When it was proposed to use coal gas for lighting, Sir Walter Scott called it "a pestilential innovation," and Napoleon considered it "une grande folie," and Byron satirized it in his verse among the passing fads.

If our last year's supply of bottled beverages had been available to Methuselah at the beginning of his alleged 969 years, he would have had eight bottles to dispose of every minute of his mortal span. The cold figures estimated by statisticians tell us that last year thirsty Americans consumed four billion bottles of soft drinks, and this total does not include beverages, such as near beer, made from cereals. This sparkling flood is poured out from 10,000 bottling establishments and over 10,000 soda counters.

Some weeds, such as wild carrot, burdock and sowthistle, are capable of producing more than 20,000 seeds to the plant. Fortunately, however, wise nature provides many ways to counteract her prodigality by seeing to it that only a very small percentage of the seeds ever amount to a weed. Else in a few years there would be no room in the world for a rose or even a modest daisy.

A little lead in brass makes it machine easily and prevents shattering. The reputation of Swedish iron is due to the manganese impurities it contains. A little copper inhibits the corrosion of steel. Small quantities of barium harden lead and make it ring like a bell.

Tadpoles derived of their thyroid and pituitary glands ordinarily will not transform into frogs; they remain tadpoles long after normal tadpoles had metamorphosed. However, if these tadpoles without their glands are fed on thyroid or substances con-

taining much iodine they can be made to transform. Some food containing iodine is necessary if tadpoles complete their life cycle. Without iodine they remain in the infantile stage.

Peyote, a Mexican habit-forming drug, which is forging its insidious way into American use, is stated to have an effect that is suggestive of the intoxication and hallucinations ascribed to the use of hasheesh or the Oriental preparations of hemp, the effect if anything, being even more treacherous, and permanently weakening the power of resistance, particularly the heart's action. Those who have watched its use by the Indians uniformly agree that the habit, unless legally curbed, is bound to be one of the greatest hindrances to the industrial progress of the Nation's wards.

The eternal fire of the ancient fire worshippers, which burned at Baku, on the Caspian Sea, was nothing but the burning gases from petroleum.

The Tower of Babel and the walls of Babylon were built with petroleum pitch as mortar. Ancient records of China and Japan refer to petroleum as a common fuel in some parts of those countries, yet although it was known there and in other parts of the world since prehistoric times, and had long been used as a medicine, it was not generally used as an illuminant until the nineteenth century.

Records of insurance companies indicate that there is an optimum weight—that is, a weight-height ratio in relation to age that is associated with the most favorable mortality experience, and that this optimum weight, or best build, is not the average build. It is stated that those who weigh between 10 and 20 per cent. below the average show the optimum condition for longevity at most ages beyond early adult life.

Ethyl alcohol, added in the proportion of 10 per cent. by volume, is a satisfactory stabilizer for hydrogen peroxide. A sample of 11.06 vols. strength exposed to air and light only tested 8.58 vols. after four months, but with the addition of alcohol in the above proportion the strength only decreased to 11.03 vols. under the same conditions during this period, and when stored in darkness a decrease of only 0.01 vol. occurred.

As high as 28,000,000 germs have been found in the digestive tract of a single house fly, and as high as 4,000,000 on its hairy legs and body, it is claimed. These figures may be two or three germs more or less, depending of course upon the originality of the counter, but they are nevertheless significant. And to think to what astronomical heights, figuratively speaking, a fly-swatter can rise, is indeed astounding.

Hold your quart thermos bottle in one hand and fill it with water. Add one drop—two will do no damage—of tincture of iodine, the ordinary seven per cent. kind that you buy at the corner drug store. Shake the water up a bit and that's all! In twenty or thirty minutes all the harmful bacteria, particularly the typhoid group that are likely to be there, will be killed, says Major A. P. Hitchens of the Medical Corps. The amount or iodine added is too slight to even taste.

BOOK REVIEWS

MIKROCHEMIE DER ARZNEIMITTEL UND GIFTE. By Dr. Adolph Mayrhofer, University of Vienna. Published by Urban and Schwarzenberg, Berlin N. 24, Friederichstrasse 105b and Wien 1, Malerstrasse 4.

This book of 275 pages and 53 illustrations deals with the microanalysis of medicinal chemicals. It outlines general methods, and gives the details of laboratory procedure for the identification of practically all common inorganic chemicals.

There is included a general scheme for the analysis of mixtures, and about 20 pages are devoted to tables giving the data for the identification of metallic salts of the more common inorganic and organic acids. An addendum deals with the determination of melting points, the sublimation, and character of sublimate, of certain important medicinal organic substances. Microanalysis, because of its applicability to small quantities of material, the simplicity and speed of the processes used, is rapidly gaining in favor.

Hence this book is a contribution of importance to the literature of analytical chemistry, and is particularly to be recommended to chemists engaged in identifying and testing medicinal chemicals, and to toxicologists.

J. W. S.

MERCK'S MANUAL OF THE MATERIA MEDICA. A ready-reference pocket book for the physician and surgeon. 5th edition, 4 x 6¼ inches, limp. Compiled and published by Merck & Co., New York.

This little volume, as necessary to the peace of mind of the young practitioner of medicine as a ready reckoner is to the young accountant, comes again, bringing with it much increment relating to the newer developments in the field of therapeutics. There is little change in the presentation and scope of this edition over the preceding editions, the only actual novelty in the issue being a chapter on the remedies which interfere with urinary tests.

While this book is primarily designed for general practitioners

and surgeons, there is within its covers much information which makes it of inestimable value to the pharmacist.

We know of no similar publication which is as well compiled, as carefully edited and as comprehensive as this little ready-reference book—and we heartily recommend it to the attention of our readers as a worthy candidate for a share of the space on that five-foot shelf of necessary pharmaceutical standard books.

I. G.